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THE CHEMICAL COMPOSITION OF WESTERN PRAIRIE SOILS AS AFFECTED BY CULTIVATION AND CROPPING

Arthur Lloyd Brown

University of Alberta

April, 1941

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THE CHEMICAL COMPOSITION OF WESTERN PRAIRIE SOILS AS AFFECTED BY CULTIVATION AND CROPPING

Arthur Lloyd Brown
Department of Soils

A THESIS
submitted to the University of Alberta
in partial fulfilment of the requirements for
the degree of
MASTER OF SCIENCE

Edmonton, Alberta
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TABLE OF CONTENTS

Page

- Introduction 1
- Review of Literature 2
- Experimental Procedure 7
    - Soil Sampling 7
    - Methods of Analysis 10
- Experimental Results 12
    - Total Nitrogen Results 28
        - Black Soils 28
        - Dark brown soils 35
        - Brown soils 41
        - Black transition soils 44
        - Gray transition soils 49
        - Gray soils 51
        - Effect of length of time of cultivation on nitrogen losses 57
    - Organic Carbon Results 59
        - Black soils 59
        - Dark brown soils 64
        - Brown soils 69
        - Black transition soils 73
        - Gray transition soils 78
        - Gray soils 81
        - Effect of length of time of cultivation on organic carbon loss 86

TABLE OF CONTENTS (cont'd.)

Page

Carbon to Nitrogen Ratios 88

Total Phosphorus Results 93

Black soils 93

Dark brown soils 99

Brown soils 104

Gray transition and Gray soils 108

Effect of length of time of cultivation on total phosphorus 112

Easily Soluble Phosphorus Results 114

Black soils 117

Dark brown soils 120

Brown soils 120

Gray transition and Gray soils 124

Water Soluble Phosphorus Results 124

Black soils 128

Dark brown soils 128

Brown soils 133

Gray transition and Gray soils 133

Nitrification Results 136

Discussion of Results 139

Nitrogen and Organic Carbon 140

Phosphorus 143

Nitrification 145

Summary 147

TABLE OF CONTENTS (cont'd.)

Page

Acknowledgment.................................... 151

Literature Cited.................................. 152

Map - Locations of Major Soil Zones............... 9

Graphs (1-10) - Nitrifying Power of Virgin and Cultivated Soil.................................... 139

THE CHEMICAL COMPOSITION OF WESTERN PRAIRIE SOILS AS AFFECTED BY CULTIVATION AND CROPPING

A. L. Brown

INTRODUCTION

Earlier work at this institution by Caldwell et al (4,5) indicated that there have been greater or lesser losses of organic matter and nitrogen from the prairie soils of Western Canada due to cultivation and cropping. The phosphorus results were less definite. However, practically no information was obtained as to whether the losses occurred rapidly after the initial breaking of the land or was a gradual loss over a long period of years. Thus the question arose--does the length of time of cultivation have any effect on the depletion of the plant foods in the soil? From the voluminous literature on this subject the suggestion is that losses of organic matter and nitrogen occur rather rapidly once the land is broken. There is, however, very little experimental data from Canada and especially in the West to substantiate this suggestion.

Thus it was felt that additional work should be done, firstly to secure data on the effect of varying lengths of time cultivated, and secondly to gather more information with regard to the effect of cultivation on phosphorus in the soil. It was also desirable to have added data on the effect of cultivation and cropping on the chemical composition of the soils.

REVIEW OF LITERATURE

There is a large amount of literature dealing with the effect that cultivation and cropping have had on the chemical composition of soils. The majority of this reported work concerns the effect on the nitrogen and organic matter of the soil. Few workers have reported experimental evidence on the effect that cultivation and cropping have had on the other important plant nutrients in the soil such as phosphorus, calcium, magnesium, sulphur and potassium.

A fairly extensive review of the literature concerning the effect of cultivation and cropping on soils has been given by Caldwell et al (4,5). His review indicates that for the most part workers agree that under the common farming practices of cropping there has been a decided loss of nitrogen and organic matter from the soil. The grain fallow system of farming appears to be the most extravagant. Crop rotations that include legumes are more likely to maintain the nitrogen and organic matter supply than any other rotations or cropping systems.

The intention of the present writer is to present some further evidence in regard to the effects that cultivation and cropping have had on the soils of Western Canada and also to bring the review of literature up to date.

De Turk (6) reports that with three rotations on the Morrow plots including continuous corn, corn-oats rotation,

REVIEW OF LITERATURE

There is a large amount of literature dealing with the effect that cultivation and cropping have had on the chemical composition of soils. The majority of this research has concerned the effect on the nitrogen and organic matter of the soil. This present paper deals more particularly [illegible] the effect that cultivation and cropping have had on the other important plant nutrients in the soil such as [illegible] calcium, magnesium, sulfur, and potassium.

A fairly extensive review of the literature dealing with the effect of cultivation and cropping on soils has been given by [illegible] (4,5). [illegible]

[illegible]

[illegible]

and a corn-oats-red clover rotation, during the past 29 years the organic carbon of the surface soil has remained practically constant on both the fertilized and unfertilized plots of the three-year rotation. A similar constancy occurred on the fertilized portion of the two-year rotation. In the other plots the organic carbon was found to undergo a progressive decline. Total nitrogen was found to follow the organic carbon rather closely.

Bracken and Greaves (3) in analyzing wheat land and adjacent virgin land in Utah found that in the first foot the sod contained about 15% more nitrogen than the wheat land. The organic matter was about 20% higher in the virgin land. In the second and third foot depths the virgin land was about 13% higher in nitrogen. In a severely eroded area the nitrogen and organic matter losses were up to 58.5% and 57.8% respectively.

A fairly extensive piece of research work has been reported from Kansas by Metzger (9,10). Here it was found that the 16-year rotation (alfalfa for four years and a corn-wheat-wheat rotation for 12 years) lost nitrogen more rapidly than the other two cropping systems (corn, soybeans and wheat; continuous wheat), but the three-year rotation lead in the rate of loss of carbon. Alfalfa grown continuously increased the soil's supply of nitrogen and carbon at the rate of 0.71% and 0.43% per year respectively. Alfalfa in continuous culture appeared to continue to add to the soil's supply of nitrogen over a period of 19 years.

Continuous wheat culture maintained a wider C:N ratio in the soil than the rotations or continuous alfalfa. In the wheat experiment green manuring tended to narrow the ratio. Manure and green manure treatments were found to maintain higher soil nitrogen and carbon levels than control plots. Commercial fertilizers tended to give similar results to the manure and green manure treatments, but were less marked.

Powers (15) found that the long continued use of manure, crop rotation with legumes, or liming in the case of acid soils, was associated with a definite increase in total nitrogen, soil organic matter and base exchange content.

Salter (17) working on the C:N ratio concluded that with a given C:N ratio the microorganic processes taking place in the soil were similar, regardless of the organic materials added. A C:N ratio wider than 10:1 causes the loss of organic carbon from the soil, while a ratio narrower than 10:1 leads to a saving of the organic carbon.

Salisbury and De Long (16) in studying virgin and cultivated soils found only small losses of organic matter as a result of cultivation.

Some workers have reported effects of cultivation and cropping on the base exchange capacity of soils.

Dorman (7) found that the percentage of the exchangeable calcium readily available was greater in the cultivated soils. Calcium, he therefore suggests, is held more firmly by

the absorbing complex of the virgin soils. He found no significant differences with other exchangeable bases such as magnesium, sodium, potassium and manganese.

Ogg and Dow (12) report a similar finding in their work on base exchange. Higher amounts of exchangeable calcium and lower "lime requirement" in the surface layer of the cultivated soils were found by these workers. They found that cultivated soils had a lime requirement of less than 0.4% of $CaCO_3$ and an exchangeable calcium of over 0.1% CaO. The cultivated soil had almost double the exchangeable calcium in the surface nine inches as compared to the adjoining uncultivated soil.

Prince, Toth, and Blair (14), however, report a lower amount of exchangeable calcium, magnesium and potash in cultivated soils.

The question of the reaction of the soil as affected by cultivation and cropping has also been approached. Ogg and Dow (12) found cultivated soils to have a pH of 5 to 7, while the uncultivated were usually less than pH5. Glinka, in the neighborhood of Leningrad, found that the pH of uncultivated soils was 4.5 while arable soil of the same class had a pH of 5.5 to 6.2. On the other hand Dorman (7) could find no change in the pH of soils due to cropping.

The question of whether cultivation and cropping has decreased the total phosphorus in the soil significantly is still a matter of conjecture. De Turk (6) found that total

phosphorus declined more under continuous corn than under a corn-oats rotation or a corn-oats-clover rotation.

Among other important plant nutrients calcium and magnesium might be mentioned. Ames and Schollenberger (2) report data that indicate in most virgin soils there is a concentration of readily soluble calcium and magnesium at the surface. With cultivated soils, however, they found that the subsoil is usually better supplied with these elements than the surface soil.

Few workers report any results of nitrification studies on cultivated and corresponding virgin soils. Metzger (10) in his studies of the nitrate content of wheat land previously cropped to alfalfa found that there was rather a marked decline in nitrate accumulating capacity in about six years after breaking the alfalfa sod.

EXPERIMENTAL PROCEDURE

Soil Sampling

Thirty-seven sets of samples were collected from various points in Alberta (including the Peace River area), Saskatchewan and Manitoba. These samples were taken to represent the major soil zones. In Alberta there are four major soil zones based on soil color. To the south and east of the province there is the brown soil zone, characterized by low precipitation and high evaporation. Between these two zones there is an area usually known as the dark brown zone which is a transition between the brown and the black zones. North and west of the black zone there is the largest zones, that is the gray wooded zone. Between the black and the gray zones there is a narrow area usually termed gray transition. In the Peace River area another zone is used, the black transition. Samples were also obtained from more recently cultivated fields as well as the older cropped and virgin land. A brief description of the major soil zones follows.

The brown soil zone occupies all of southeastern Alberta and consists of prairie land. The average annual precipitation is about 12 inches. Evaporation in this area is fairly high and so this is the driest zone in the province. The soil is low in organic matter and characterized by a relatively thin A and B horizon with the lime layer close to

the surface.

To the west and north of the brown zone is the dark brown zone, a transition zone. This is characterized by plains and park belt soils. It is equal in area to the brown soil zone.

The black zone is found to the west and north of the dark brown zone. It is characterized by the presence of clumps and scattered areas of poplars, willows, and other trees. The soil is rich in organic matter and the A_1 horizon has an average depth of 12 inches. The B horizon is generally well developed, and the B_2 or lime layer occurs at a depth of from 2½ to 4 feet.

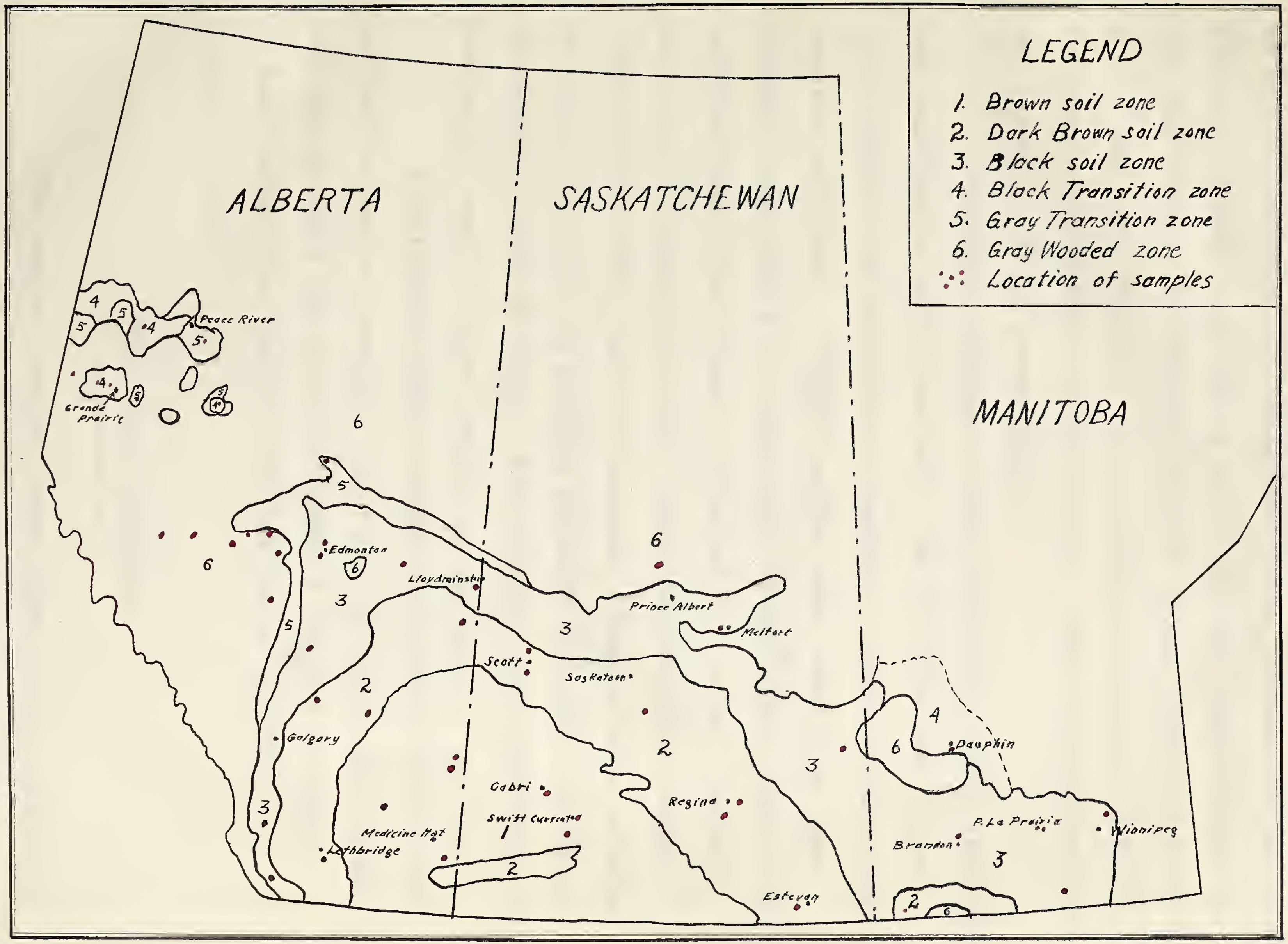
The gray wooded zone, lying west and north of the black zone, is fairly heavily wooded and for the most part characterized by an A_0 layer of vegetable mold of about 2 inches. The A_1 and A_2 horizons comprise about 8 to 10 inches of grayish leached soil. The B_1 is slightly darker in color and usually heavy in structure, while the B_2 or lime layer is usually found from 2 to 6 feet below the surface. Similar zones occur in Saskatchewan.

A more detailed description of these various zones and profiles has been given by Wyatt and Newton (23).

The accompanying map outlines the soil zones in the three prairie provinces, and the locations of samples are marked.

In the field samples were taken according to profile

SKETCH MAP SHOWING LOCATIONS OF MAJOR SOIL ZONES


LEGEND
1. Brown soil zone
2. Dark Brown soil zone
3. Black soil zone
4. Black Transition zone
5. Gray Transition zone
6. Gray Wooded zone
∴ Location of samples
ALBERTA
SASKATCHEWAN
MANITOBA
Peace River
Grande Prairie
Edmonton
Lloydminster
Calgary
Medicine Hat
Lethbridge
Scott
Saskatoon
Prince Albert
Melfort
Cabri
Swift Current
Regina
Estevan
Dauphin
Brandon
P. La Prairie
Winnipeg

as far as possible. In some cases the A_1 horizon of the black soil was divided into two so as to have one sample represent the plow depth. In the case of gray wooded soils the surface A_0, A_1 and part or all of the A_2 horizons were put together in order to represent the plow depth. The average plow depth was taken as six to seven inches.

Duplicate samples of both virgin and cultivated soil were obtained at each location. For the first two layers (i.e. surface and subsurface) composite samples of ten small samples were taken. Virgin samples were taken from some unbroken area nearby the cultivated fields or along fence lines and roadsides. The oldest cultivated fields in a district were usually sought and where possible some more recently broken field nearby was also sampled. Samples were obtained by using the spade and digging suitable trenches from which the samples could be taken. Soil classes were determined by moistening some soil and rubbing in the palm of the hand.

Fertilized fields, eroded and drifted fields were avoided as much as possible since each of these would complicate the project and would be indeed a project in itself. In some cases it is doubtful if erosion or drifting could be entirely avoided.

Methods of Analysis

The samples obtained were taken to the laboratory where the larger stones and heavier debris were removed.

They were then air-dried, well mixed and finally ground as fine as possible in a Braun pulverizer.

Total nitrogen was determined by the Kjeldahl-Gunning-Hibbard method, modified by the addition of selenium as a catalyst (A.O.A.C.11).

Organic carbon was determined by Schollenberger's (18,19) chromic acid reduction method as modified by Allison (1). The organic matter was calculated by multiplying organic carbon by the factor 1.724.

Total phosphorus was determined volumetrically after fusing with magnesium nitrate--a modified procedure taken from the A.O.A.C.(11).

Easily soluble phosphorus was determined colorimetrically according to Truog (21).

Water soluble phosphorus was determined by the Deniges colorimetric method as modified by Parker and Fudge (13).

In the nitrification studies samples were incubated at optimum moisture and at a temperature of 25°C. Periodically samples were removed for nitrate determinations. After 90 days the remaining samples were leached practically free of nitrates, brought to optimum moisture and reincubated. The determination itself was done colorimetrically by the phenol-di-sulphonic acid method given by Harper (8).

EXPERIMENTAL RESULTS

Table 1 presents the total nitrogen, organic carbon and total phosphorus in percent for all the samples analyzed for these elements. The easily soluble phosphorus and water-soluble phosphorus are not included because they are expressed in parts per million and are only for the surface samples. The results for nitrates appear also in a separate table.

Total nitrogen was determined on every sample.

Organic carbon was determined on every sample except the lime layer. The lime layer was not analyzed for carbon because no corresponding sample was obtained from the cultivated field. In some cases, however, the lime layer sample was also analyzed for organic carbon.

Total phosphorus was determined only on the first and second depths, while easily soluble phosphorus and water-soluble phosphorus were determined only on the surface samples. In the case of gray wooded samples no phosphorus was determined on the A_0 or A_1 single samples, since no corresponding cultivated samples could be taken, but only on the composite samples.

In Table 1 is given the sample number, its location, its zone and class, virgin or cultivated, and depth in inches. The number of years cultivated is given in the other tables. Although the nitrogen and carbon results for samples 327 to

467 inclusive were reported by Caldwell (4), they are included here for purposes of completeness of record. The phosphorus results for samples 327 to 467 inclusive were not available when Caldwell finished his thesis but have since been made attainable. It was thought advisable to include the nitrogen and carbon results for these samples and thus have a complete record. The nitrogen and carbon results for samples numbered 327 to 467 inclusive only appear in Table 1 and are not used in other tables where losses or gains are given.

In most cases farming practices have been similar. The important crops grown have been wheat, oats and barley. Fallowing has been practised, usually every third or fourth year. Thus this work has been chiefly to find out the effects of a grain-fallow system of farming. The Brooks samples were obtained from an irrigated field.

Continuous wheat has been grown on the Breton plots E-1 and E-3, with a fallow in 1932 and again for two successive years in 1937 and 1938. The other years, from 1928 to 1938, wheat has been grown. E-1 is a check plot while E-3 has received complete fertilizer every year. The fertilizer has consisted of 60 pounds of ammonium phosphate (16-20) and 30 pounds of potassium sulphate per acre each year. The samples were collected from the Breton plots in the fall of 1938.

The data contained in Table 1 is rearranged to show losses or gains in percent as well as pounds per acre in the following tables (Tables 2 to 36 inclusive).

Table 1. Total nitrogen, carbon and total phosphorus in percent

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N[x] %	C[x] %	P %
327	Grosmont	Gr.Tr.[#]	Lt.Si.L.[xx]	Virgin	0-8	.135	1.84	.076
328	"	"	C.L.	"	8-20	.064	0.43	.047
332	"	"	Lt.Si.L.	"	0-8	.139	1.91	.075
333	"	"	C.L.	"	8-20	.060	0.54	.044
334	"	"	Lt.Si.L.	Cult.	0-8	.134	1.62	.075
335	"	"	"	"	8-20	.066	0.54	.044
336	"	"	"	"	0-8	.135	1.59	.069
337	"	"	"	"	8-20	.054	0.43	.049
338	Lloyd-minster	Bl.	L.	Virgin	0-5	.411	5.33	.064
339		"	Si.L.	"	5-11	.059	0.70	.024
342	"	"	L.	"	0-5	.414	5.50	.064
343	"	"	Si.L.	"	5-11	.090	1.11	.033
345	"	"	L.	Cult.	0-7	.396	5.03	.086
346	"	"	Si.L.	"	7-11	.114	1.31	.050
348	"	"	L.	"	0-7	.402	5.11	.087
349	"	"	Si.L.	"	7-11	.160	1.88	.067
351	Scott	Dk.Br.	L.	Virgin	0-7	.240	3.09	.071
352	"	"	Si.L.	"	7-14	.085	1.02	.048
354	"	"	L.	"	0-7	.257	3.24	.073
355	"	"	Si.L.	"	7-14	.091	1.11	.044
357	"	"	L.	Cult.	0-7	.247	3.18	.078
358	"	"	Si.L.	"	7-14	.094	1.12	.064
359	"	"	L.	"	0-7	.253	3.20	.081
360	"	"	Si.L.	"	7-14	.085	0.94	.061

[x] The nitrogen and carbon results for samples numbered 327 to 467 inclusive were obtained from Caldwell's thesis (1938). They are included here for purposes of record. The phosphorus results for these samples were not available at that time but the analyses have since been carried out by Caldwell and are reported herein.

[#] Bl. - Black
Dk.Br. - Dark Brown
Br. - Brown
Bl.Tr. - Black Transition
Gr.Tr. - Gray Transition
Gr. - Gray

[xx] L. - Loam
Si.L. - Silt Loam
C. - Clay
C.L. - Clay Loam
F.S.L. - Fine Sandy Loam
S.L. - Sandy Loam

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
361	Cutknife	Dk.Br.	L.	Virgin	0-7	.337	4.48	.088
362	"	"	Si.L.	"	7-22	.087	1.09	.049
364	"	"	L.	"	0-7	.335	4.51	.086
365	"	"	Si.L.	"	7-28	.068	0.87	.048
367	"	"	L.	Cult.	0-7	.242	3.02	.071
368	"	"	Si.L.	"	7-26	.063	0.84	.045
369	"	"	L.	"	0-7	.241	3.08	.069
370	"	"	Si.L.	"	7-22	.063	0.81	.044
371	Tweedsmuir	Gr.Wd.	F.S.L.	Virgin	0-7	.115	2.30	.049
372	"	"	S.L.	"	7-36	.012	0.18	.039
374	"	"	F.S.L.	"	0-7	.109	2.31	.049
375	"	"	S.L.	"	7-36	.010	0.20	.039
377	"	"	F.S.L.	Cult.	0-7	.079	1.63	.051
378	"	"	S.L.	"	7-36	.010	0.22	.045
379	"	"	F.S.L.	"	0-7	.079	1.72	.052
380	"	"	S.L.	"	7-36	.007	0.19	.041
381	Melfort	B.L.	L.	Virgin	0-7	.648	8.41	.112
382	"	"	Si.L.	"	7-14	.347	4.43	.084
385	"	"	L.	"	0-7	.643	8.30	.114
386	"	"	Si.L.	"	7-14	.293	3.68	.082
389	"	"	L.	Cult.	0-7	.541	6.96	.096
390	"	"	Si.L.	"	7-14	.361	4.38	.085
392	"	"	L.	"	0-7	.548	7.08	.099
393	"	"	Si.L.	"	7-14	.485	5.60	.087
395	Regina-South	Dk.Br.	C.	Virgin	0-6	.313	3.34	.080
396		"	"	"	6-16	.157	1.44	.063
398	"	"	"	"	0-6	.313	3.40	.074
399	"	"	"	"	6-16	.171	1.60	.063
401	"	"	C.	Cult.	0-6	.183	1.76	.061
402	"	"	"	"	6-16	.123	1.14	.055
403	"	"	"	"	0-6	.175	1.67	.060
404	"	"	"	"	6-16	.187	1.86	.055
405	Regina-East	Dk.Br.	L.	Virgin	0-6	.331	4.29	.086
406		"	C.L.	"	6-18	.094	1.15	.053
408	"	"	L.	"	0-6	.323	4.34	.081
409	"	"	C.L.	"	6-18	.082	1.02	.050
411	"	"	L.	Cult.	0-6	.202	2.61	.062
412	"	"	C.L.	"	6-16	.069	0.77	.040
413	"	"	L.	"	0-6	.197	2.53	.063
414	"	"	C.L.	"	6-16	.085	0.94	.047

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
415	Swift Current	Br.	L.	Virgin	0-6	.398	5.45	.093
416		"	"	"	6-15	.109	1.33	.055
419	"	"	"	"	0-6	.390	5.24	.086
420	"	"	"	"	6-15	.099	1.20	.044
423	"	"	L.	Cult.	0-6	.271	3.35	.067
424	"	"	"	"	6-16	.118	1.35	.049
426	"	"	"	"	0-6	.256	3.23	.075
427	"	"	"	"	6-15	.109	1.22	.054
429	Cabri	Br.	C.	Virgin	0-7	.136	1.27	.064
430	"	"	"	"	7-21	.097	0.95	.058
432	"	"	"	"	0-7	.132	1.27	.062
433	"	"	"	"	7-21	.103	0.92	.057
435	"	"	C.	Cult.	0-7	.126	0.87	.056
436	"	"	"	"	7-22	.097	0.89	.054
437	"	"	"	"	0-7	.124	1.16	.056
438	"	"	"	"	7-22	.100	0.89	.055
439	Lethbridge	Dk.Br.	Si.L.	Virgin	0-6	.207	2.60	.060
440		"	"	"	6-18	.106	1.20	.055
442	"	"	"	"	0-6	.205	2.52	.057
443	"	"	"	"	6-18	.097	1.16	.051
445	"	"	L.	Cult.	0-6	.133	1.60	.054
446	"	"	Si.L.	"	6-12	.100	1.07	.053
448	"	"	L.	"	0-6	.126	1.52	.052
449	"	"	Si.L.	"	6-12	.117	1.30	.059
451	Lacombe	Bl.	L.	Virgin	0-6	.444	5.79	.084
452	"	"	"	"	6-15	.257	3.45	.068
454	"	"	"	"	0-6	.435	5.72	.083
455	"	"	"	"	6-15	.287	3.81	.069
457	Morrin	Dk.Br.	C.	Virgin	0-6	.417	5.02	.078
458	"	"	"	"	6-12	.216	2.25	.064
460	"	"	"	"	0-6	.408	4.78	.076
461	"	"	"	"	6-12	.210	2.09	.063
463	"	"	"	Cult.	0-6	.325	3.46	.067
464	"	"	"	"	6-12	.228	2.22	.061
466	"	"	"	"	0-6	.325	3.41	.069
467	"	"	"	"	6-12	.210	1.93	.060
469	Lloydminster	Bl.	L.	Virgin	0-8	.591	7.29	.075
470		"	Si.L.	"	8-11	.132	1.36	.037
471	"	"	L.	"	0-8	.507	6.29	.069
472	"	"	Si.L.	"	8-11	.126	1.45	.043

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
473	Hanley	Dr.Br.	L.	Virgin	0-7	.197	2.25	.061
474	"	"	Si.L.	"	7-15	.069	0.72	.062
475	"	"	L.	"	0-7	.191	2.19	.060
476	"	"	Si.L.	"	7-15	.090	0.87	.060
477	"	"	L.	Cult.	0-7	.173	1.88	.059
478	"	"	Si.L.	"	7-15	.066	0.65	.053
479	"	"	L.	"	0-7	.186	2.01	.060
480	"	"	Si.L.	"	7-15	.082	0.78	.055
481	Yorkton	Bl.	L.	Virgin	0-7	.515	5.82	.085
482	"	"	Si.L.	"	7-15	.202	2.33	.068
483	"	"	"	"	15-19	.063	0.51	
484	"	"	L.	"	0-7	.509	5.77	.081
485	"	"	Si.L.	"	7-15	.174	1.86	.067
486	"	"	"	"	15-19	.057	0.54	
487	"	"	L.	Cult.	0-7	.401	4.55	.076
488	"	"	Si.L.	"	7-15	.182	1.85	.059
489	"	"	L.	"	0-7	.373	4.54	.083
490	"	"	Si.L.	"	7-13	.198	2.07	.055
491	Dauphin	Bl.Tr.	C.L.	Virgin	0-8	.650	7.31	.153
492	"	"	"	"	8-16	.379	4.24	.127
493	"	"	"	"	16-22	.129	1.67	
494	"	"	"	"	0-8	.638	7.21	.153
495	"	"	"	"	8-16	.350	3.80	.118
496	"	"	"	"	16-22	.133	1.68	
497	"	"	"	Cult.	0-8	.597	6.46	.148
498	"	"	"	"	8-16	.426	4.70	.122
499	"	"	"	"	0-8	.601	6.43	.145
500	"	"	"	"	8-16	.426	4.56	.127
501	Brandon	Bl.	F.S.L.	Virgin	0-7	.456	5.78	.072
502	"	"	"	"	7-17	.171	2.02	.047
503	"	"	L.	"	17-21	.074	0.72	
504	"	"	F.S.L.	"	0-7	.456	5.93	.072
505	"	"	"	"	7-17	.173	1.99	.053
506	"	"	L.	"	17-21	.068	0.68	
507	"	"	F.S.L.	Cult.	0-7	.313	3.82	.061
508	"	"	"	"	7-17	.154	1.82	.047
509	"	"	"	"	0-7	.301	3.93	.061
510	"	"	"	"	7-17	.157	1.83	.046

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
511	Portage La Prairie	Bl.	Si.L.	Virgin	0-8	.426	5.33	.083
512		"	"	"	8-20	.193	2.33	.066
513	"	"	C.L.	"	20-24	.060	0.61	
514	"	"	Si.L.	"	0-8	.427	5.43	.087
515	"	"	"	"	8-20	.196	2.33	.066
516	"	"	C.L.	"	20-24	.058	0.64	
517	"	"	Si.L.	Cult.	0-8	.367	4.34	.082
518	"	"	"	"	8-17	.174	2.04	.069
519	"	"	"	"	0-8	.358	4.31	.079
520	"	"	"	"	8-17	.172	2.00	.067
521	Selkirk	Bl.	C.L.	Virgin	0-8	.708	8.92	.121
522	"	"	C.	"	8-18	.244	2.77	.062
523	"	"	"	"	18-32	.116	1.15	
524	"	"	"	"	32-36	.097	0.94	
525	"	"	C.L.	"	0-8	.709	9.00	.118
526	"	"	C.	"	8-18	.247	2.78	.059
527	"	"	"	"	18-32	.152	1.61	
528	"	"	"	"	32-36	.102	0.96	
529	"	"	C.L.	Cult.	0-8	.523	6.42	.095
530	"	"	C.	"	8-20	.200	2.15	.057
531	"	"	C.L.	"	0-8	.506	6.17	.095
532	"	"	C.	"	8-20	.202	2.21	.057
533	Winkler	Bl.	F.S.L.	Virgin	0-7	.262	3.11	.063
534	"	"	L.	"	7-17	.348	4.36	.073
535	"	"	Si.L.	"	17-32	.240	3.27	
536	"	"	"	"	32-46	.113	1.21	
537	"	"	C.L.	"	46-51	.055	0.45	
538	"	"	F.S.L.	"	0-7	.265	3.28	.066
539	"	"	L.	"	7-17	.346	4.34	.077
540	"	"	Si.L.	"	17-32	.262	3.32	
541	"	"	"	"	32-52	.106	1.15	
542	"	"	C.L.	"	52-57	.054	0.47	
543	"	"	F.S.L. to L.	Cult.	0-7	.295	3.74	.066
544	"	"	F.S.L.	"	7-17	.271	3.41	.063
545	"	"	"	"	0-7	.281	3.52	.065
546	"	"	"	"	7-17	.269	3.37	.063

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
547	Waskada	Dk.Br.	L.	Virgin	0-6	.431	5.28	.079
548	"	"	Si.L.	"	6-13	.245	2.74	.060
549	"	"	C.L.	"	13-17	.132	1.20	
550	"	"	L.	"	0-6	.424	5.14	.078
551	"	"	Si.L.	"	6-13	.263	3.03	.063
552	"	"	C.L.	"	13-17	.128	1.15	
553	"	"	L.	Cult.	0-6	.315	3.67	.066
554	"	"	Si.L.	"	6-12	.265	2.82	.061
555	"	"	L.	"	0-6	.337	3.81	.066
556	"	"	Si.L.	"	6-12	.280	3.16	.059
557	Estevan	Dk.Br.	L.	Virgin	0-6	.359	4.44	.064
558	"	"	Si.L. to C.L.	"	6-14	.115	1.20	.039
559	"	"	C.L.	"	14-18	.090	0.85	
560	"	"	L.	"	0-6	.383	4.63	.067
561	"	"	Si.L.to C.L	"	6-14	.114	1.17	.040
562	"	"	C.L.	"	14-18	.082	0.76	
563	"	"	L.	Cult.	0-6	.204	2.30	.053
564	"	"	Si.L.to C.L	"	6-18	.088	0.68	.043
565	"	"	L.	"	0-6	.223	2.35	.056
566	"	"	Si.L.to CL.	"	6-18	.082	0.67	.042
567	Lacombe	Bl.	L.	Virgin	0-6	.388	4.81	.077
568	"	"	C.L.	"	6-15	.276	3.27	.072
569	"	"	L.	"	0-6	.435	5.44	.082
570	"	"	C.L.	"	6-15	.276	3.20	.070
571	Vegreville	Bl.	L.	Cult.	0-8	.458	5.96	.110
572		"	C.L.	"	8-14	.131	1.52	.064
573	"	"	"	"	14-20	.072	0.80	
574	"	"	L.	"	0-8	.458	6.00	.114
575	"	"	C.L.	"	8-14	.121	1.28	.062
576	"	"	"	"	14-20	.070	0.71	
577	Lloydminster	Bl.	L.	Virgin	0-7	.577	7.17	.084
578		"	Si.L.	"	7-14	.182	2.02	.053
579	"	"	C.L.	"	14-20	.063	0.60	
580	"	"	L.	"	0-7	.607	7.41	.082
581	"	"	Si.L.	"	7-14	.195	2.08	.051
582	"	"	C.L.	"	14-20	.066	0.58	
583	"	"	L.	Cult.	0-7	.570	6.65	.090
584	"	"	Si.L.	"	7-14	.129	1.32	.045
585	"	"	C.L.	"	14-20	.052	0.54	
586	"	"	L.	"	0-7	.538	6.43	.088
587	"	"	Si.L.	"	7-14	.128	1.30	.043
588	"	"	C.L.	"	14-20	.051	0.51	

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
589	Mackay	Gr.Wd.		Virgin	0-2	1.194	21.48	
590	"	"	Si.L.	"	2-7	.061	0.78	
591	"	"	"	"	0-7	.204	2.98	.189
592	"	"	C.	"	7-14	.048	0.45	.070
594	"	"	C.	"	14-36	.045	0.46	
594	"	"	Si.L.	"	0-7	.181	2.50	.151
595	"	"	C.	"	7-14	.044	0.44	.084
596	"	"	C.	"	14-36	.041	0.42	
597	"	"	Si.L.	Cult.	0-7	.202	3.08	.180
598	"	"	C.	"	7-14	.048	0.45	.082
599	"	"	C.	"	14-36	.047	0.48	
600	"	"	Si.L.	"	0-7	.177	3.29	.151
601	"	"	C.	"	7-14	.047	0.45	.070
602	"	"	C.	"	14-36	.041	0.43	
603	Carrot	Gr.Wd.		Virgin	0-2	.759	16.25	
604	Creek	"	Si.L.	"	2-7	.047	0.55	
605	"	"	"	"	0-7	.142	2.15	.069
606	"	"	C.L.	"	7-14	.052	0.44	.042
607	"	"	C.	"	14-36	.056	0.53	
608	"	"	Si.L.	"	0-7	.137	1.95	.067
609	"	"	C.L.	"	7-14	.051	0.41	.043
610	"	"	C.	"	14-36	.053	0.52	
611	"	"	Si.L.	Cult.	0-7	.117	2.00	.069
612	"	"	C.L.	"	7-14	.048	0.44	.042
613	"	"	C.	"	14-36	.058	0.56	
614	"	"	Si.L.	"	0-7	.118	1.93	.069
615	"	"	C.L.	"	7-14	.055	0.43	.041
616	"	"	C.	"	14-36	.062	0.50	
617	Edson	Gr.Wd.		Virgin	0-1	.443	9.08	
618	"	"	Si.L.	"	1-7	.045	0.47	
619	"	"	"	"	0-7	.083	1.32	.065
620	"	"	C.	"	7-14	.048	0.42	.049
621	"	"	C.	"	14-36	.027	0.29	
622	"	"	Si.L.	"	0-7	.084	1.31	.065
623	"	"	C.	"	7-14	.049	0.41	.046
624	"	"	C.	"	14-36	.034	0.38	
625	"	"	Si.L.	Cult.	0-7	.067	0.85	.042
626	"	"	C.	"	7-14	.051	0.46	.035
627	"	"	C.	"	14-36	.028	0.40	
628	"	"	Si.L.	"	0-7	.066	0.83	.039
629	"	"	C.	"	7-14	.048	0.44	.033
630	"	"	C.	"	14-36	.024	0.28	

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
631	Gunn	Gr.Wd.		Virgin	0-2	.953	18.40	
632	"	"	L.	"	2-7	.061	0.84	
633	"	"	L.	"	0-7	.174	3.05	.095
634	"	"	C.L.	"	7-14	.049	0.37	.055
635	"	"	C.	"	14-36	.045	1.37	
636	"	"	L.	"	0-7	.187	3.33	.096
637	"	"	C.L.	"	7-14	.050	0.51	.056
638	"	"	C.	"	14-36	.042	0.48	
639	"	"	L.	Cult.	0-7	.162	2.64	.089
640	"	"	C.L.	"	7-14	.044	0.41	.050
641	"	"	C.	"	14-36	.045	0.44	
642	"	"	L.	"	0-7	.148	2.62	.086
643	"	"	C.L.	"	7-14	.041	0.44	.052
644	"	"	C.	"	14-36	.038	0.37	
645	Cherhill	Gr.Wd.		Virgin	0-2	.504	8.52	
646	"	"		"	2-7	.077	1.07	
647	"	"	L.	"	0-7	.133	2.02	.044
648	"	"	C.	"	7-14	.044	0.51	.030
649	"	"	C.	"	14-36	.041	0.47	
650	"	"	L.	"	0-7	.136	2.23	.046
651	"	"	C.	"	7-14	.047	0.49	.029
652	"	"	C.	"	14-36	.041	0.50	
653	"	"	L.	Cult.	0-7	.120	1.74	.051
654	"	"	C.	"	7-14	.056	0.53	.033
655	"	"	C.	"	14-36	.053	0.52	
656	"	"	L.	"	0-7	.123	1.73	.051
657	"	"	C.	"	7-14	.059	0.53	.033
658	"	"	C.	"	14-36	.044	0.51	
659	Breton	"		Virgin	0-2	1.084	23.90	
660	"	"	Si.L.	"	2-7	.064	0.86	
661	"	"	"	"	0-7	.140	2.70	.075
662	"	"	C.	"	7-14	.048	0.51	.040
663	"	"	"	"	14-36	.035	0.36	
664	"	"	Si.L.	"	0-7	.162	2.92	.074
665	"	"	C.	"	7-14	.045	0.48	.040
666	"	"	C.	"	14-36	.034	0.39	
667	"	"	Si.L.	Cult.E-1	0-7	.108	1.41	.061
668	"	"	C.	"	7-14	.049	0.53	.041
669	"	"	"	"	14-36	.034	0.34	
670	"	"	Si.L.	"	0-7	.103	1.37	.060
671	"	"	C.	"	7-14	.045	0.52	.039
672	"	"	"	"	14-36	.030	0.36	
673	"	"	Si.L.	Cult.E-3	0-7	.103	1.45	.068
674	"	"	C.	"	7-14	.044	0.47	.039
675	"	"	C.	"	14-36	.041	0.34	

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
676	Breton	Gr.Wd.	Si.L.	Cult.E-3	0-7	.104	1.43	.065
677	"	"	C.	"	7-14	.046	0.49	.039
678	"	"	"	"	14-36	.028	0.32	
679	Breton	Gr.Wd.		Virgin	0-2	1.197	29.33	
680	"	"	Si.L.	"	2-7	.064	0.90	
681	"	"	"	"	0-7	.118	2.32	.059
682	"	"	C.	"	7-14	.041	0.41	.049
683	"	"	"	"	14-36	.034	0.42	
684	"	"	Si.L.	"	0-7	.108	2.05	.063
685	"	"	C.	"	7-14	.041	0.37	.047
686	"	"	"	"	14-36	.025	0.36	
687	"	"	Si.L.	Cult.	0-7	.108	1.75	.058
688	"	"	C.	"	7-14	.045	0.43	.043
689	"	"	C.	"	14-36	.033	0.31	
690	"	"	Si.L.	"	0-7	.112	1.89	.058
691	"	"	C.	"	7-14	.044	0.44	.044
692	"	"	"	"	14-36	.030	0.30	
693	Edgerton	Dk.Br.	L.	Virgin	0-7	.411	5.46	.106
694	"	"	Si.L.	"	7-12	.135	1.59	.063
695	"	"	C.	"	12-23	.080	0.89	
696	"	"	"	"	23-29	.041	0.34	
697	"	"	L.	"	0-7	.430	5.53	.097
698	"	"	Si.L.	"	7-12	.126	1.56	.057
699	"	"	C.	"	12-23	.081	0.82	
700	"	"	L.	Cult.	0-7	.328	4.13	.078
701	"	"	Si.L.	"	7-12	.154	1.66	.056
702	"	"	C.	"	12-23	.115	1.20	
703	"	"	L.	"	0-7	.325	4.13	.076
704	"	"	Si.L.	"	7-12	.148	1.70	.067
705	"	"	C.	"	12-23	.094	0.86	
706	Morrin	Dk.Br.	C.	Virgin	0-6	.332	3.54	.071
707	"	"	"	"	6-12	.224	2.11	.061
708	"	"	"	"	12-22	.142	1.36	
709	"	"	"	"	0-6	.322	3.65	.069
710	"	"	"	"	6-12	.235	2.28	.067
711	"	"	"	"	12-22	.185	1.71	
712	"	"	"	Cult.	0-6	.291	2.92	.068
713	"	"	"	"	6-12	.197	1.75	.061
714	"	"	"	"	12-22	.115	1.02	
715	"	"	"	"	0-6	.308	3.22	.071
716	"	"	"	"	6-12	.191	1.69	.060
717	"	"	"	"	12-22	.131	1.21	

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
718	Hand	Dk.Br.	L.-Si.L.	Virgin	0-6	.345	4.63	.076
719	Hills	"	Si.L. to C.L.	"	6-12	.125	1.30	.036
720	"	"	C.L.	"	12-18	.101	1.03	
721	"	"	"	"	18-24	.067	0.83	
722	"	"	L.-Si.L.	"	0-6	.357	4.77	.086
723	"	"	Si.L. to C.L.	"	6-12	.126	1.15	.036
724	"	"	C.L.	"	12-18	.073	1.00	
725	"	"	L.-Si.L.	Cult.	0-6	.265	3.32	.065
726	"	"	Si.L. to C.L.	"	6-12	.135	1.37	.041
727	"	"	C.L.	"	12-18	.123	1.57	
728	"	"	L.-Si.L.	"	0-6	.248	3.10	.060
729	"	"	Si.L. to C.L.	"	6-12	.136	1.42	.040
730	"	"	C.L.	"	12-18	.086	0.89	
731	Brooks	Br.	L.	Virgin	0-6	.285	3.64	.075
732	"	"	Si.L.	"	6-12	.114	1.07	.066
733	"	"	"	"	12-24	.056	0.56	
734	"	"	"	"	24-36	.058	0.53	
735	"	"	L.	"	0-6	.302	3.61	.074
736	"	"	Si.L.	"	6-12	.111	1.04	.061
737	"	"	"	"	12-24	.048	0.40	
738	"	"	L.	Cult.	0-6	.270	3.19	.082
739	"	"	Si.L.	"	6-12	.131	1.15	.081
740	"	"	"	"	12-24	.077	0.59	
741	"	"	L.	"	0-6	.273	3.26	.083
742	"	"	Si.L.	"	6-12	.125	1.13	.079
743	"	"	"	"	12-24	.056	0.50	
744	Cavendish	Br.	L.	Virgin	0-6	.145	1.69	.056
745	"	"	"	"	6-14	.076	0.82	.046
746	"	"	Si.L.	"	14-20	.067	0.75	
747	"	"	L.	"	0-6	.160	1.79	.056
748	"	"	"	"	6-14	.078	0.80	.046
749	"	"	"	Cult.	0-6	.154	1.64	.057
750	"	"	"	"	6-14	.111	0.96	.055
751	"	"	"	"	0-6	.164	1.71	.064
752	"	"	"	"	6-14	.100	0.91	.060
753	Gros	Br.	L.	Virgin	0-6	.292	3.73	.074
754	Ventre	"	C.L.	"	6-12	.089	0.94	.051
755	"	"	"	"	12-21	.098	0.93	
756	"	"	L.	"	21-27	.047	0.47	
757	"	"	"	"	0-6	.291	3.89	.069
758	"	"	C.L.	"	6-12	.090	0.97	.044
759	"	"	"	"	12-21	.062	0.64	
760	"	"	L.	Cult.	0-6	.172	1.89	.055
761	"	"	C.L.	"	6-12	.091	0.88	.046

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
762	Gros	Br.	C.L.	Cult.	12-17	.061	0.64	
763	Ventre	"	L.	"	0-6	.160	1.87	.053
764	"	"	C.L.	"	6-12	.087	0.89	.045
765	"	"	"	"	12-17	.080	0.70	
766	Leth-	Dk.Br.	L.	Virgin	0-6	.217	2.57	.062
767	bridge	"	Si.L.	"	6-12	.126	1.20	.055
768	"	"	"	"	12-19	.098	0.97	
769	"	"	L.	"	0-6	.217	2.49	.060
770	"	"	Si.L.	"	6-12	.118	1.19	.057
771	"	"	L.	Cult.	0-6	.229	2.57	.066
772	"	"	Si.L.	"	6-11	.149	1.47	.060
773	"	"	L.	"	0-6	.232	2.57	.069
774	"	"	Si.L.	"	6-11	.156	1.53	.070
775	Pincher	Bl.	Si.L.	Virgin	0-8	.578	7.36	.114
776	Creek	"	C.L.-C.	"	8-18	.157	1.66	.063
777	"	"	C.	"	18-33	.084	0.85	
778	"	"	"	"	33-39	.042	0.44	
779	"	"	Si.L.	"	0-8	.529	6.69	.121
780	"	"	C.L.-C.	"	8-18	.156	1.64	.066
781	"	"	Si.L.	Cult.	0-8	.313	3.77	.100
782	"	"	C.L.-C.	"	8-18	.123	1.05	.072
783	"	"	Si.L.	"	0-8	.338	4.05	.092
784	"	"	C.L.-C.	"	8-18	.131	1.07	.074
785	Parkland	Bl.	L.-Si.L.	Virgin	0-6	.357	4.31	.079
786	"	"	Si.L.	"	6-15	.143	1.59	.058
787	"	"	C.L.	"	15-21	.076	0.84	
788	"	"	L.-Si.L.	"	0-6	.331	4.11	.071
789	"	"	Si.L.	"	6-15	.143	1.56	.057
790	"	"	L.-Si.L.	Cult.	0-6	.331	3.90	.082
791	"	"	Si.L.	"	6-15	.149	1.56	.062
792	"	"	L.-Si.L.	"	0-6	.324	3.82	.084
793	"	"	Si.L.	"	6-15	.131	1.48	.057
794	Debolt	Gr.Tr.	H.C.L.	Virgin	0-6	.279	2.65	
795	"	"	"	"	6-12	.094	0.81	
796	"	"	C.	"	12-24	.097	0.84	
797	"	"	"	"	24-30	.077	0.85	
798	"	"	H.C.L.	"	0-6	.276	2.64	
799	"	"	"	"	6-12	.104	0.84	
800	"	"	C.	"	12-24	.082	0.72	
801	"	"	H.C.L.	Cult.	0-6	.311	2.85	

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
802	Debolt	Gr.Tr.	H.C.L.	Cult.	6-12	.104	0.93	
803	"	"	C.	"	12-24	.085	0.87	
804	"	"	H.C.L.	"	0-6	.298	2.86	
805	"	"	"	"	6-12	.101	0.92	
806	"	"	C.	"	12-24	.090	0.83	
807	"	"	H.C.L.	"	0-6	.283	3.31	
808	"	"	"	"	6-12	.093	0.81	
809	"	"	C.	"	12-24	.098	0.71	
810	"	"	H.C.L.	"	0-6	.280	3.35	
811	"	"	"	"	6-12	.093	0.71	
812	"	"	C.	"	12-24	.095	0.87	
816	Goodfare	Gr.Wd.		Virgin	0-2	.465	7.37	
817	"	"	Si.L.	"	2-8	.053	0.62	
818	"	"	"	"	0-8	.173	2.54	
819	"	"	C.	"	8-14	.093	0.77	
820	"	"	"	"	14-25	.100	1.03	
821	"	"	"	"	25-31	.098	0.88	
822	"	"	Si.L.	"	0-8	.158	2.31	
823	"	"	C.	"	8-14	.093	0.79	
824	"	"	"	"	14-25	.104	1.03	
825	"	"	Si.L.	Cult.	0-6	.136	1.69	
826	"	"	C.	"	6-12	.103	1.02	
827	"	"	"	"	12-24	.101	1.07	
828	"	"	Si.L.	"	0-6	.143	1.64	
829	"	"	C.	"	6-12	.096	0.87	
830	"	"	"	"	12-24	.108	1.01	
831	Grande Prairie	Bl.Tr.	Si.L.	Virgin	0-6	.349	4.08	
832		"	Lt.C.*	"	6-12	.132	1.24	
833	"	"	H.C.	"	12-24	.111	1.07	
834	"	"	C.	"	24-30	.079	0.93	
835	"	"	Si.L.	"	0-6	.372	4.10	
836	"	"	Lt.C.	"	6-12	.143	1.26	
837	"	"	H.C.	"	12-24	.110	1.11	
838	"	"	Si.L.	Cult.	0-6	.360	3.60	
839	"	"	Lt.C.	"	6-12	.128	1.12	
840	"	"	H.C.	"	12-26	.127	1.10	
841	"	"	Si.L.	"	0-6	.353	3.57	
842	"	"	Lt.C.	"	6-12	.133	1.12	
843	"	"	H.C.	"	12-26	.137	1.13	

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* Light clay.

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
850	Beaver-lodge	Bl.Tr.	Lt.C.L.	Virgin	0-6	.666	7.16	
851		"	C.L.	"	6-10	.151	1.68	
852	"	"	C.	"	10-(26 (20	.134	1.27	
853	"	"	"	"	20)- 26)	.121	1.27	
854	"	"	Lt.C.L.	"	0-6	.697	7.48	
855	"	"	C.L.	"	6-10	.158	1.75	
856	"	"	C.	"	10-(20 (26	.125	1.18	
857	"	"	Lt.C.L.	Cult.	0-6	.647	6.71	
858	"	"	C.L.	"	6-10	.155	1.43	
859	"	"	C.	"	10-(20 (26	.129	1.19	
860	"	"	Lt.C.L.	"	0-6	.657	6.49	
861	"	"	C.L.	"	6-10	.143	1.43	
862	"	"	C.	"	10-(20 (26	.129	1.29	
863	Fairview	Bl.Tr.	Si.L.	Virgin	0-6	.714	8.45	
864	"	"	C.L.	"	6-12	.181	1.97	
865	"	"	C.	"	12-27	.111	0.98	
866	"	"	"	"	27-	.065	0.50	
867	"	"	Si.L.	"	0-6	.746	8.81	
868	"	"	C.L.	"	6-12	.202	2.13	
869	"	"	C.	"	12-27	.123	1.26	
870	"	"	Si.L.	Cult.	0-6	.529	5.64	
871	"	"	C.L.	"	6-12	.163	1.50	
872	"	"	C.	"	12-27	.105	0.96	
873	"	"	Si.L.	"	0-6	.526	5.70	
874	"	"	C.L.	"	6-12	.162	1.55	
875	"	"	C.	"	12-27	.104	0.83	
876	"	"	Si.L.-L.	Virgin	0-7	.794	8.90	
877	"	"	Lt.C.L.	"	7-13	.169	1.61	
878	"	"	C.	"	13-30	.114	1.09	
879	"	"	"	"	30-36	.085	0.82	
880	"	"	Si.L.-L.	"	0-7	.814	9.19	
881	"	"	Lt.C.L.	"	7-13	.177	1.72	
882	"	"	C.	"	13-30	.092	0.82	
883	"	"	Si.L.-L.	Cult.	0-7	.552	6.12	
884	"	"	Lt.C.L.	"	7-13	.149	1.22	
885	"	"	C.	"	13-30	.115	0.98	
886	"	"	Si.L.-L.	"	0-7	.520	5.81	
887	"	"	Lt.C.L.	"	7-13	.129	1.20	
888	"	"	C.	"	13-30	.110	1.04	

Table 1 (continued)

Sample No.	Location	Zone	Class	Virgin or cult.	Depth in inches	N %	C %	P %
892	Nampa	Gr.Tr.	C.L.	Virgin	0-6	.612	7.18	
893	"	"	C.	"	6-12	.173	1.35	
894	"	"	"	"	12-32	.115	0.85	
895	"	"	"	"	32)-38 36)	.114	1.24	
896	"	"	C.L.	"	0-6	.591	7.32	
897	"	"	C.	"	6-12	.148	1.23	
898	"	"	"	"	12-32	.139	1.04	
899	"	"	C.L.	Cult.	0-6	.402	4.66	
900	"	"	C.	"	6-12	.166	1.31	
901	"	"	"	"	12-32	.117	0.99	
902	"	"	C.L.	"	0-6	.414	4.56	
903	"	"	C.	"	6-12	.181	1.25	
904	"	"	"	"	12-32	.117	1.05	
905	"	"	C.L.	"	0-6	.418	4.17	
906	"	"	C.	"	6-12	.206	1.72	
907	"	"	"	"	12-32	.111	0.73	
908	"	"	C.L.	"	0-6	.447	4.15	
909	"	"	C.	"	6-12	.174	1.37	
910	"	"	"	"	12-32	.107	0.69	
911	High Prairie	Bl.Tr.	C.L.	Virgin	0-5	.990	12.85	
912		"	C.	"	5-12	.188	2.41	
913	"	"	"	"	12-18	.213	2.39	
914	"	"	"	"	18-24	.176	2.11	
915	"	"	C.L.	"	0-5	1.020	13.50	
916	"	"	C.	"	5-12	.166	2.12	
917	"	"	"	"	12-18	.167	2.02	
918	"	"	C.L.	Cult.	0-5	.568	7.15	
919	"	"	C.	"	5-12	.163	1.99	
920	"	"	"	"	12-18	.173	1.79	
921	"	"	C.L.	"	0-5	.516	6.95	
922	"	"	C.	"	5-12	.160	1.94	
923	"	"	"	"	12-18	.208	1.92	
924	"	"	C.L.	Virgin	0-7	.883	11.86	
925	"	"	C.	"	7-14	.151	1.83	
926	"	"	Si.L.-C.L.	"	14-20	.107	1.34	
927	"	"	C.L.	"	0-7	.830	10.99	
928	"	"	C.	"	7-14	.145	1.77	
929	"	"	Si.L.-C.L.	"	14-20	.078	1.07	
930	"	"	C.L.	Cult.	0-7	.745	8.81	
931	"	"	C.	"	7-14	.117	1.30	
932	"	"	Si.L.-C.L.	"	14-20	.074	0.79	
933	"	"	C.L.	"	0-7	.748	8.84	
934	"	"	C.	"	7-14	.108	1.29	
935	"	"	Si.L.-C.L.	"	14-20	.080	0.95	

Total Nitrogen Results

In Tables 2 to 13 inclusive is presented a comparison of nitrogen in virgin and corresponding cultivated fields in 51 locations. In this case a location refers to each cultivated field sampled even though only one set of virgin samples was obtained in certain cases to compare with two sets of cultivated samples. Thus Vegreville is counted as two locations since two cultivated fields were sampled there. The samples and results are arranged according to soil zones and each zone will thus be dealt with separately.

Black Soils

The results expressed in percent and in percentage loss or gain for the samples from the black soils are given in Table 2. In this table the number of years cultivated is given so that in many cases the older and more recently cultivated soils can be compared.

An investigation of Table 2 reveals the fact that in the surface layers from 14 locations only 3 locations show a gain in percent nitrogen, namely, Lacombe, Vegreville and Winkler. Losses range from 0.007% to 0.228% nitrogen while gains only from 0.024% to 0.046% nitrogen. Considering both losses and gains, the average loss has been 0.087% nitrogen in all surface layers.

In the subsurface layer there are 9 locations that show losses from 0.003% to 0.077% nitrogen, and 5 locations that show gains from 0.002% to 0.051% nitrogen. The average

Table 2. Total nitrogen in virgin and cultivated black soils and loss or gain of nitrogen in cultivated soil

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Lloyd-minster	L.	Virgin	469	0-8	.591		
	"	"	471	"	.507	.549	
"	"	Cult. 30 yrs.	345*	0-7	.396		
"	"	"	348*	"	.402	.399	-.150
"	Si.L.	Virgin	470	8-11	.132		
"	"	"	472	"	.126	.129	
"	"	Cult.	346*	7-11	.114		
"	"	"	349*	"	.160	.137	+.008
Lloyd-minster	L.	Virgin	577	0-7	.577		
	"	"	580	"	.607	.592	
"	"	Cult. 5 yrs.	583	"	.570		
"	"	"	586	"	.538	.554	-.038
"	Si.L.	Virgin	578	7-14	.182		
"	"	"	581	"	.195	.189	
"	"	Cult.	584	"	.129		
"	"	"	587	"	.128	.129	-.060
"	C.L.	Virgin	579	14-20	.063		
"	"	"	582	"	.066	.065	
"	"	Cult.	585	"	.052		
"	"	"	588	"	.051	.052	-.013
Lacombe	L.	Virgin	567	0-6	.388		
"	"	"	569	"	.435	.412	
"	"	Cult. 26 yrs.	451*	"	.444		
"	"	Rot. 0	454*	"	.435	.440	+.028
"	C.L.	Virgin	568	6-15	.276		
"	"	"	570	"	.276	.276	
"	"	Cult.	452*	"	.257		
"	"	"	455*	"	.287	.272	-.004
Vegre-ville	L.	Virgin	276**	0-8	.404		
	"	"	280**	"	.419	.412	
"	"	Cult. 10 yrs.	571	"	.458		
"	"	"	574	"	.458	.458	+.046

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* Results for these samples obtained from Caldwell's thesis (1938); virgin soil at Lloydminster and Lacombe resampled in 1938.

** Figures obtained from Caldwell's thesis (1938) to give a comparison of older and newer fields.

Table 2 (continued)

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Vegreville	L.	Cult. 30 yrs.	284[*]	0-6	.414		
	"	"	288[*]	"	.396	.405	-.007
"	C.L.	Virgin	278[*]	8-26	.089		
"	"	"	282[*]	8-34	.060	.075	
"	"	Cult. 10 yrs.	572	8-14	.131		
"	"	"	575	"	.121	.126	+.051
"	"	Cult. 30 yrs.	286[*]	6-26	.075		
"	"	"	290[*]	6-27	.088	.082	+.007
"	C.L.	Cult. 10 yrs.	573	14-20	.072		
"	"	"	576	"	.070	.071	-.004
Pincher Creek	Si.L.	Virgin	121[*]	0-7	.574		
	"	"	125[*]	"	.580	.577	
"	"	Cult. 27 yrs.	129[*]	"	.399		
"	"	"	133[*]	"	.396	.398	-.179
"	C.	Virgin	123[*]	7-22	.153		
"	"	"	127[*]	"	.119	.136	
"	"	Cult.	131[*]	"	.126		
"	"	"	135[*]	"	.150	.138	+.002
"	Si.L.	Virgin	775	0-8	.578		
"	"	"	779	"	.529	.554	
"	"	Cult. 13 yrs.	781	"	.313		
"	"	"	783	"	.338	.326	-.228
"	C.	Virgin	776	8-18	.157		
"	"	"	780	"	.156	.157	
"	"	Cult.	782	"	.123		
"	"	"	784	"	.131	.127	-.030
Parkland	L.	Virgin	137[*]	0-6	.438		
"	"	"	141[*]	"	.411	.425	
"	"	Cult. 27 yrs.	145[*]	"	.267		
"	"	"	149[*]	"	.255	.261	-.164
"	C.L.	Virgin	139[*]	6-20	.140		
"	"	"	143[*]	6-16	.252	.196	
"	"	Cult.	147[*]	6-14	.158		
"	"	"	151[*]	6-13	.161	.160	-.036
Parkland	L.	Virgin	785	0-6	.357		
"	"	"	788	"	.331	.344	
"	"	Cult. 10 yrs.	790	"	.331		

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[*] Figures obtained from Caldwell's thesis (1938) to give a comparison of older and newer fields.

Table 2 (continued)

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of dupli-cates	Gain or loss
Parkland	L.	Cult. 10 yrs.	792	0-6	.324	.328	-.016
"	Si.L.	Virgin	786	6-15	.143		
"	"	"	789	"	.143	.143	
"	"	Cult.	791	"	.149		
"	"	"	793	"	.131	.140	-.003
Yorkton	L.	Virgin	481	0-7	.515		
"	"	"	484	"	.509	.512	
"	"	Cult. 40 yrs.	487	"	.401		
"	"	"	489	"	.373	.387	-.125
"	Si.L.	Virgin	482	7-15	.202		
"	"	"	485	"	.174	.188	
"	"	Cult.	488	"	.182		
"	"	"	490	7-13	.198	.190	+.002
Brandon	F.S.L.	Virgin	501	0-7	.456		
"	"	"	504	"	.456	.456	
"	"	Cult. 50 yrs.	507	"	.313		
"	"	"	509	"	.301	.307	-.149
"	"	Virgin	502	7-17	.171		
"	"	"	505	"	.173	.172	
"	"	Cult.	508	"	.154		
"	"	"	510	"	.157	.156	-.016
Portage La Prairie	Si.L.	Virgin	511	0-8	.426		
"	"	"	514	"	.427	.427	
"	"	Cult. 50 yrs.	517	"	.367		
"	"	"	519	"	.358	.363	-.064
"	"	Virgin	512	8-20	.193		
"	"	"	515	"	.196	.195	
"	"	Cult.	518	8-17	.174		
"	"	"	520	"	.172	.173	-.022
Selkirk	C.L.	Virgin	521	0-8	.708		
"	"	"	525	"	.709	.709	
"	"	Cult.35 yrs.	529	"	.523		
"	"	"	531	"	.506	.515	-.194
"	C.	Virgin	522	8-18	.244		
"	"	"	526	"	.247	.246	
"	"	Cult.	530	8-20	.200		
"	"	"	532	"	.202	.201	-.045

Table 2 (continued)

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of dupli-cates	Gain or loss
Winkler	L.	Virgin	533	0-7	.262		
"	"	"	538	"	.265	.264	
"	"	Cult. 50 yrs.	543	"	.295		
"	"	"	545	"	.281	.288	+.024
"	"	Virgin	534	7-17	.348		
"	"	"	539	"	.346	.347	
"	"	Cult.	544	"	.271		
"	"	"	546	"	.269	.270	-.077

for all locations in this layer is a loss of only 0.016% nitrogen. Below this the results are more variable, and not all locations were sampled below the subsurface.

Very little information can be gathered from this table as to the effect of length of time of cultivation. However, a comparison to show this is given in a later table (Table 14).

The results for Winkler appear to be somewhat irregular in that the subsurface layer contains more nitrogen than the surface layer. Also the surface layer shows a gain of nitrogen in the cultivated sample, while the subsurface layer shows a loss of nitrogen. This may be explained by the fact that it is probable that drifting has occurred in this area and that the surface depth is composed chiefly of drifted soil, while the second depth represents the original surface soil.

The losses and gains in Table 2 are not all comparable since the depths sampled are not all the same. Thus a clearer picture of the effect of cultivation and cropping on black soils may be obtained from a study of Table 3. Here the losses or gains are presented on a pounds per acre basis for each 6-inch depth. Losses in the first 6-inch depth from 11 locations range from 288 pounds to 4,104 pounds per acre, while the gains from three locations range from 432 pounds to 828 pounds per acre. The average of all locations shows a loss of 1,667 pounds per acre.

In the second six-inch depth 13 locations likewise show losses which vary from 54 pounds to 1,728 pounds per acre. One location shows a gain of 888 pounds per acre. The average of all 14 locations shows a loss of 688 pounds per acre of nitrogen for this layer.

Since composite samples of the lower layers were not obtained, gains or losses cannot be so well established below the subsurface layer.

Table 3. Loss or gain of nitrogen in cultivated black soils on a pounds per acre basis

	Depth in inches			Total gain or loss
Location	0-6	6-12	12-18	
Lloydminster	-2,700	-1,590		-4,290
"	-684	-1,014	-516	-2,214
Lacombe	+504	-72		+432
Vegreville	-1,582	-443	+126	-1,899
"	+828	+888	+258	+1,974
Pincher Creek	-3,222	-507	+36	-3,693
" "	-4,104	-1,728	-540	-6,372
Parkland	-2,952	-648	-1041	-4,641
"	-288	-54		-342
Yorkton	-2,250	-345		-2,595
Brandon	-2,682	-687	-288	-3,657
P. La Prairie	-1,152	-648	-396	-2,196
Selkirk	-3,492	-1,704	-810	-6,006
Winkler	+432	-1,083	-1,386	-2,037
Average gain or loss	-1,667	-688	-456	

Dark Brown Soils

The comparison of total nitrogen in virgin and cultivated dark brown soils may be found in Tables 4 and 5. Table 4 gives the percentage figures while Table 5 presents the pounds per acre figures.

Turning to Table 4, there are 9 locations showing losses varying from 0.014% to 0.157% nitrogen, whereas there are only two locations showing gains. These gains amount to 0.002% and 0.014% nitrogen for Hand Hills and Lethbridge respectively. The average has been a loss for the surface layer of 0.061% of nitrogen. In the subsurface layer the picture is somewhat reversed. Here there are only 3 losses of 0.006%, 0.030% and 0.036% of nitrogen while there are 8 gains ranging from 0.004% to 0.031% of nitrogen. The average for all locations is a very small gain of 0.005% nitrogen. This is practically within the experimental error.

Only a few results of samples from lower depths are reported and thus no comparisons can be given.

A better idea of the losses and gains may be had from a glance at Table 5. In the surface 6 inches losses have occurred in 9 locations ranging from 252 pounds to 2,826 pounds per acre. The two gains are only 36 pounds and 252 pounds per acre for Hand Hills and Lethbridge respectively. The average for the 11 locations has been a loss of 1,090 pounds of nitrogen per acre.

Table 4. Total nitrogen in virgin and cultivated dark brown soils and loss or gain of nitrogen in cultivated soil

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Edgerton	L.	Virgin	292*	0-8	.342		
"	"	"	296*	"	.329	.336	
"	"	Cult. 26 yrs.	300*	"	.290		
"	"	"	303*	"	.322	.306	-.030
"	Si.L.	Virgin	294*	8-17	.118		
"	"	"	298*	8-21	.110	.114	
"	"	Cult.	301*	8-20	.110		
"	"	"	305*	"	.126	.118	+.004
"	"	Virgin	295*	17-24	.058		
"	"	"	299*	21-27	.065	.062	
"	"	Cult.	302*	20-26	.069		
"	"	"	306*	"	.067	.068	+.006
Edgerton	L.	Virgin	693	0-7	.411		
"	"	"	697	"	.430	.421	
"	"	Cult. 12 yrs.	700	"	.328		
"	"	"	703	"	.325	.327	-.094
"	Si.L.	Virgin	694	7-12	.135		
"	"	"	698	"	.126	.131	
"	"	Cult.	701	"	.154		
"	"	"	704	"	.148	.151	+.020
"	C.	Virgin	695	12-23	.080		
"	"	"	699	"	.081	.081	
"	"	Cult.	702	"	.115		
"	"	"	705	"	.094	.105	+.024
Morrin	C	Virgin	457*	0-6	.417		
"	"	"	460*	"	.408	.413	
"	"	Cult. 26 yrs.	463*	"	.325		
"	"	"	466*	"	.325	.325	-.088
"	"	Virgin	458*	6-12	.216		
"	"	"	461*	"	.210	.213	
"	"	Cult.	464*	"	.228		
"	"	"	467*	"	.210	.219	+.006
"	"	Virgin	459*	12-20	.154		
"	"	"	462*	"	.175	.165	
"	"	Cult.	465*	"	.214		
"	"	"	468*	"	.174	.194	+.029

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* See footnote page 30.

Table 4 (continued)

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Morrin	C	Virgin	706	0-6	.332		
"	"	"	709	"	.322	.327	
"	"	Cult. 13 yrs.	712	"	.291		
"	"	"	715	"	.308	.300	-.027
"	"	Virgin	707	6-12	.224		
"	"	"	710	"	.235	.230	
"	"	Cult.	713	"	.197		
"	"	"	716	"	.191	.194	-.036
"	"	Virgin	708	12-22	.142		
"	"	"	711	"	.185	.164	
"	"	Cult.	714	"	.115		
"	"	"	717	"	.131	.123	-.041
Hand Hills	L.	Virgin	17[*]	0-8	.207		
"	"	"	20[*]	"	.234	.221	
"	"	Cult. 20 yrs.	23[*]	0-6	.239		
"	"	"	26[*]	0-8	.207	.223	+.002
"	C.L.	Virgin	18[*]	8-14	.102		
"	"	"	21[*]	"	.110	.106	
"	"	Cult.	24[*]	6-12	.149		
"	"	"	27[*]	8-14	.119	.134	+.028
"	"	Virgin	19[*]	14-22	.057		
"	"	"	22[*]	"	.065	.061	
"	"	Cult.	25[*]	12-20	.070		
"	"	"	28[*]	14-22	.078	.074	+.013
Hand Hills	L.	Virgin	718	0-6	.345		
"	"	"	722	"	.357	.351	
"	"	Cult. 9 yrs.	725	"	.265		
"	"	"	728	"	.248	.257	-.094
"	C.L.	Virgin	719	6-12	.125		
"	"	"	723	"	.126	.126	
"	"	Cult.	726	"	.135		
"	"	"	729	"	.136	.136	+.010
"	"	Virgin	720	12-18	.101		
"	"	"	724	"	.073	.087	
"	"	Cult.	727	"	.123		
"	"	"	730	"	.086	.105	+.018

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[*] See footnote page 30.

Table 4 (continued)

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Lethbridge	Si.L.	Virgin	439*	0-6	.207		
	"	"	442*	"	.205	.206	
"	"	Cult. Rot. C (Dry land)	445*	"	.133		
"	"		448*	"	.126	.130	-.076
"	"	Virgin	440*	6-18	.106		
"	"	"	443*	"	.097	.102	
"	"	Cult.	446*	6-12	.100		
"	"	"	449*	"	.117	.109	+.007
Lethbridge	L.	Virgin	766	0-6	.217		
	"	"	769	"	.217	.217	
"	"	Cult. 8 yrs.	771	"	.229		
"	"	"	773	"	.232	.231	+.014
"	Si.L.	Virgin	767	6-12	.126		
"	"	"	770	"	.118	.122	
"	"	Cult.	772	6-12	.149		
"	"	"	774	"	.156	.153	+.031
Estevan	L.	Virgin	557	0-6	.359		
"	"	"	560	"	.383	.371	
"	"	Cult. 35 yrs.	563	"	.204		
"	"	"	565	"	.223	.214	-.157
"	C.L.	Virgin	558	6-14	.115		
"	"	"	561	"	.114	.115	
"	"	Cult.	564	6-18	.088		
"	"	"	566	"	.082	.085	-.030
Hanley	L.	Virgin	473	0-7	.197		
"	"	"	475	"	.191	.194	
"	"	Cult. 30 yrs.	477	"	.173		
"	"	"	479	"	.186	.180	-.014
"	Si.L.	Virgin	474	7-15	.069		
"	"	"	476	"	.090	.080	
"	"	Cult.	478	"	.066		
"	"	"	480	"	.082	.074	-.006

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* See footnote page 30.

Table 4 (continued)

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of dupli-cates	Gain or loss
Waskada	L.	Virgin	547	0-6	.431		
"	"	"	550	"	.424	.428	
"	"	Cult. 30 yrs.	553	"	.315		
"	"	"	555	"	.337	.326	-.102
"	Si.L.	Virgin	548	6-13	.245		
"	"	"	551	"	.263	.254	
"	"	Cult.	554	6-12	.265		
"	"	"	556	"	.280	.273	+.019

In the 6 to 12 inch depth at four locations there have been losses of from 42 pounds to 648 pounds per acre, while at 7 locations where gains occurred they have ranged from 18 pounds to 558 pounds per acre. The average figure for all locations amounts to a gain of 8 pounds per acre.

In the 12 to 18 inch depth there are only 3 locations showing losses and 5 showing gains. The average has been a gain of 75 pounds of nitrogen per acre.

At the extreme right of Table 5 may be found the total gain or loss of nitrogen in pounds per acre for the depths indicated. It will be noticed that only in two locations is there a gain.

Table 5. Loss or gain of nitrogen in cultivated dark brown soils on a pounds per acre basis

	Depth in inches				Total gain or loss
Location	0-6	6-12	12-18	18-24	
Waskada	-1,836	+342			-1,494
Edgerton	-540	-42	+207	+101	-274
"	-1,692	+18	+432		-1,242
Morrin	-1,584	+108	+522		-954
"	-486	-648	-738		-1,872
Hand Hills	+36	+122	+245	+245	+648
"	-1,692	+180	+324		-1,188
Lethbridge	-1,368	+126	-198		-1,440
"	+252	+558			+810
Estevan	-2,826	-540	-192		-3,558
Hanley	-252	-132			-384
Average gain or loss	-1,090	+8	+75	+173	

Brown Soils

The nitrogen results for brown soil samples are contained in Tables 6 and 7.

In Table 6 the percentage figures are given with average of duplicate samples and the gain or loss in percent. Five out of 6 locations show losses varying from 0.022% to 0.126% nitrogen for the surface layer. The only gain occurred at Cavendish and amounts to only 0.006% nitrogen. The average loss for this layer was 0.056% nitrogen. It will also be noted that the two sets of samples from Brooks have been taken from irrigated fields.

In the subsurface layer losses occur at two places, both at Gros Ventre, amounting to 0.033% and 0.001% nitrogen. The four gains range from 0.012% to 0.029% nitrogen. The average in this layer is a gain of 0.006% nitrogen. This is a low figure and is probably not significant.

At Brooks the increase apparently extends down to the third depth as is evident from the table. At Gros Ventre, however, a loss occurs in all horizons analyzed.

Table 7 gives the loss or gain of nitrogen in cultivated brown soils on a pounds per acre basis. In the first 6-inch depth only one out of 6 locations shows an increase, and that is Cavendish which apparently has gained 108 pounds per acre. The five losses range from 441 pounds to 2,268 pounds of nitrogen per acre. The average of all six locations is a loss of 989 pounds per acre.

Table 6. Total nitrogen in virgin and cultivated brown soils and loss or gain of nitrogen in cultivated soils

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Gros Ventre	L.	Virgin	73[*]	0-6	.295		
	"	"	77[*]	"	.287	.291	
"	"	Cult. 20 yrs.	81[*]	"	.186		
"	"	"	85[*]	"	.185	.186	-.105
"	C.L.	Virgin	75[*]	6-20	.105		
"	"	"	79[*]	"	.116	.111	
"	"	Cult.	83[*]	"	.075		
"	"	"	87[*]	6-24	.081	.078	-.033
Gros Ventre	L.	Virgin	753	0-6	.292		
	"	"	757	"	.291	.292	
"	"	Cult. 9 yrs.	760	"	.172		
"	"	"	763	"	.160	.166	-.126
"	C.L.	Virgin	754	6-12	.089		
"	"	"	758	"	.090	.090	
"	"	Cult.	761	"	.091		
"	"	"	764	"	.087	.089	-.001
"	"	Virgin	755	12-21	.098		
"	"	"	759	"	.062	.080	
"	"	Cult.	762	12-17	.061		
"	"	"	765	"	.080	.071	-.009
Cavendish	F.S.L.	Virgin	41[*]	0-5	.158		
"	"	"	45[*]	"	.146	.152	
"	"	Cult. 23 yrs.	49[*]	"	.130		
"	"	"	53[*]	"	.110	.120	-.032
"	"	Virgin	43[*]	5-12	.093		
"	"	"	47[*]	"	.105	.099	
"	"	Cult.	51[*]	"	.122		
"	"	"	55[*]	"	.102	.112	+.013
Cavendish	L.	Virgin	744	0-6	.145		
"	"	"	747	"	.160	.153	
"	"	Cult. 11 yrs.	749	"	.154		
"	"	"	751	"	.164	.159	+.006
"	"	Virgin	745	6-14	.076		
"	"	"	748	"	.078	.077	
"	"	Cult.	750	"	.111		
"	"	"	752	"	.100	.106	+.029

[*] See footnote page 30.

Table 6 (continued)

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Brooks	F.S.L.	Virgin	1[★]	0-9	.158		
"	"	"	5[★]	"	.159	.159	
"	"	Cult. Irrig. 12 yrs.	9[★]	"	.105		
"	"	"	13[★]	"	.097	.101	-.058
"	"	Virgin	2[★]	9-16	.062		
"	"	"	6[★]	"	.063	.063	
"	"	Cult.	10[★]	"	.080		
"	"	"	14[★]	"	.069	.075	+.012
"	"	Virgin	3[★]	16-36	.045		
"	"	"	7[★]	"	.033	.039	
"	"	Cult.	11[★]	"	.047		
"	"	"	15[★]	"	.047	.047	+.008
Brooks	L.	Virgin	731	0-6	.285		
"	"	"	735	"	.302	.294	
"	"	(Cult. 3 yrs.	738	"	.270		
"	"	(Irrig.	741	"	.273	.272	-.022
"	Si.L.	Virgin	732	6-12	.114		
"	"	"	736	"	.111	.113	
"	"	Cult.	739	"	.131		
"	"	"	742	"	.125	.128	+.015
"	"	Virgin	733	12-24	.056		
"	"	"	737	"	.048	.052	
"	"	Cult.	740	"	.077		
"	"	"	743	"	.056	.067	+.015

[★] See footnote page 30.

In the second 6-inch depth there are 3 losses and 3 gains which all average out to zero. In the third 6-inch depth only 4 figures are given, two of which are gains and two losses. The average is a loss of only 74 pounds per acre. In the 18 to 24 inch layer the only two figures given are gains. As in previous tables, the extreme right hand column gives the total loss or gain of nitrogen in pounds per acre for the depths shown.

Table 7. Loss or gain of nitrogen in cultivated brown soils on a pounds per acre basis

	Depth in inches				Total gain or loss
Location	0-6	6-12	12-18	18-24	
Gros Ventre	-1,890	-594	-594		-3,078
"	-2,268	-18	-162		-2,448
Cavendish	-441	+234			-207
"	+108	+522			+630
Brooks	-1,044	-414	+192	+144	-1,122
"	-396	+270	+270	+270	+414
Average gain or loss	-989	±0	-74	+207	

Black Transition Soils

The nitrogen results for black transition soil samples are found in Tables 8 and 9.

Table 8 presents the results in percent. In every case in the surface layer a loss of nitrogen occurs ranging from 0.004% to 0.463%. The average loss is 0.160% nitrogen in the cultivated soils from the black transition zone.

Table 8. Total nitrogen in virgin and cultivated soils from the black transition zone and loss or gain of nitrogen in cultivated soils

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
High Prairie	C.L.	Virgin	911	0-5	.990		
"	"	"	915	"	1.020	1.005	
"	"	Cult. 30 yrs.	918	"	.568		
"	"	"	921	"	.516	.542	-.463
"	C.	Virgin	912	5-12	.188		
"	"	"	916	"	.166	.177	
"	"	Cult.	919	"	.163		
"	"	"	922	"	.160	.162	-.015
"	"	Virgin	913	12-18	.213		
"	"	"	917	"	.167	.190	
"	"	Cult.	920	"	.173		
"	"	"	923	"	.208	.191	+.001
High Prairie	C.L.	Virgin	924	0-7	.883		
"	"	"	927	"	.830	.857	
"	"	Cult. 11 yrs.	930	"	.745		
"	"	"	933	"	.748	.747	-.110
"	C.	Virgin	925	7-14	.151		
"	"	"	928	"	.145	.148	
"	"	Cult.	931	"	.117		
"	"	"	934	"	.108	.113	-.035
"	"	Virgin	926	14-20	.107		
"	"	"	929	"	.078	.093	
"	"	Cult.	932	"	.074		
"	"	"	935	"	.080	.077	-.016
Fairview	Si.L.	Virgin	876	0-7	.794		
"	"	"	880	"	.814	.804	
"	"	Cult. 29 yrs.	883	"	.552		
"	"	"	886	"	.520	.536	-.268
"	L.C.L.	Virgin	877	7-13	.169		
"	"	"	881	"	.177	.173	
"	"	Cult.	884	"	.149		
"	"	"	887	"	.129	.139	-.034
"	C.	Virgin	878	13-30	.114		
"	"	"	882	"	.092	.103	
"	"	Cult.	885	"	.115		
"	"	"	888	"	.110	.113	+.010

Table 8 (continued)

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Fairview	Si.L.	Virgin	863	0-6	.714		
"	"	"	867	"	.746	.730	
"	"	Cult. 12 yrs.	870	"	.529		
"	"	"	873	"	.526	.528	-.202
"	C.L.	Virgin	864	6-12	.181		
"	"	"	868	"	.202	.192	
"	"	Cult.	871	"	.163		
"	"	"	874	"	.162	.163	-.029
"	C.	Virgin	865	12-27	.111		
"	"	"	869	"	.123	.117	
"	"	Cult.	872	"	.105		
"	"	"	875	"	.104	.105	-.012
Beaverlodge	L.C.L.	Virgin	850	0-6	.666		
	"	"	854	"	.697	.682	
"	"	Cult. 22 yrs.	857	"	.647		
"	"	"	860	"	.657	.652	-.030
"	C.L.	Virgin	851	6-10	.151		
"	"	"	855	"	.158	.155	
"	"	Cult.	858	"	.155		
"	"	"	861	"	.143	.149	-.006
"	C.	Virgin	852	10-(20 (26	.134		
"	"	"	856	"	.125	.130	
"	"	Cult.	859	"	.129		
"	"	"	862	"	.129	.129	-.001
Grande Prairie	Si.L.	Virgin	831	0-6	.349		
	"	"	835	"	.372	.361	
"	"	Cult. 25 yrs.	838	"	.360		
"	"	"	841	"	.353	.357	-.004
"	L.C.	Virgin	832	6-12	.132		
"	"	"	836	"	.143	.138	
"	"	Cult.	839	"	.128		
"	"	"	842	"	.133	.131	-.007
"	H.C.	Virgin	833	12-24	.111		
"	"	"	837	"	.110	.111	
"	"	Cult.	840	12-26	.127		
"	"	"	843	"	.137	.132	+.021

Table 8 (continued)

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Dauphin	H.C.L.	Virgin	491	0-8	.650		
"	"	"	494	"	.638	.644	
"	"	Cult. 45 yrs.	497	"	.597		
"	"	"	499	"	.601	.599	-.045
"	C.L.	Virgin	492	8-16	.379		
"	"	"	495	"	.350	.365	
"	"	Cult.	498	"	.426		
"	"	"	500	"	.426	.426	+.061

In the second depth there is a loss in 6 cases ranging from 0.006% to 0.035% nitrogen, while Dauphin shows a gain of 0.061% nitrogen. The average loss for the 7 locations is 0.009% nitrogen in the cultivated soil.

In the third depth there are 3 losses and 3 gains with the average practically at zero.

In this percentage table the depths are not all comparable so that an examination of the next table (Table 9) will give a clearer picture of the results. Here are presented the figures on a pounds per acre basis for each 6-inch depth. In the first 6-inch depth losses range from 72 pounds to 6,990 pounds of nitrogen per acre at the 7 locations. This gives an average of 2,693 pounds per acre. In the second 6-inch depth 6 locations show losses of nitrogen and one shows a gain, namely Dauphin. The losses range from 108 pounds to 1,314 pounds per acre; the one gain is 462 pounds per acre and the average is a loss of 388 pounds of nitrogen.

Table 9. Loss or gain of nitrogen in cultivated soils from the black transition zone on a pounds per acre basis

	Depth in inches				Total gain or loss
Location	0-6	6-12	12-18	18-24	
High Prairie	-6,990	-270	+18		-7,242
" "	-1,980	-855	-402		-3,237
Fairview	-4,824	-1,314	+48	+180	-5,910
"	-3,636	-504	-196	-196	-4,532
Beaverlodge	-540	-108	-18		-666
Grande Prairie	-72	-126	+378	+378	+558
Dauphin	-810	+462			-348
Average gain or loss	-2,693	-388	-28	+121	

In the 12 to 18 inch depth there are 3 losses and 3 gains with an average loss of 28 pounds. This is a low figure and probably of no significance. Only 3 figures are given for the 18 to 24 inch depth, 2 of which are gains. On the average these 3 locations show gains of 121 pounds of nitrogen per acre in the 18 to 24 inch depth. Total gains or losses are given in the extreme right hand column. Only one location shows a gain, viz., Grande Prairie.

Gray Transition Soils

In Tables 10 and 11 may be found the comparisons for total nitrogen in virgin and cultivated gray transition soils. It will be noticed that there are only 2 locations in this zone. However, at each location 2 different cultivated sets of samples were obtained, that is, a recently broken field and a field that has been cultivated for some time.

In the surface layers, both Nampa cultivated samples show losses of nitrogen, while at Debolt the 2 cultivated samples show increases in nitrogen content over the virgin samples. In the subsurface or second layer Nampa shows 2 increases while Debolt shows one increase and one decrease. In the subsoil or third layer Nampa again reveals a loss of nitrogen in the cultivated samples, while at Debolt one field shows a gain and the other one neither a loss or gain.

The comparisons are brought out more clearly in Table 11 where the results are given on a pounds per acre basis for each 6-inch depth. In the 0 to 6 inch depth 2 losses and 2 gains give an average loss of 1,494 pounds of nitrogen per

Table 10. Total nitrogen in virgin and cultivated gray transition soils and loss or gain of nitrogen in cultivated soil

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Nampa	C.L.	Virgin	892	0-6	.612		
"	"	"	896	"	.591	.602	
"	"	Cult. 20 yrs.	899	"	.402		
"	"	"	902	"	.414	.408	-.194
"	"	Cult. 5 yrs.	905	"	.418		
"	"	"	908	"	.447	.433	-.169
"	C.	Virgin	893	6-12	.173		
"	"	"	897	"	.148	.161	
"	"	Cult. 20 yrs.	900	"	.166		
"	"	"	903	"	.181	.174	+.013
"	"	Cult. 5 yrs.	906	"	.206		
"	"	"	909	"	.174	.190	+.029
"	"	Virgin	894	12-32	.115		
"	"	"	898	"	.139	.127	
"	"	Cult. 20 yrs.	901	"	.117		
"	"	"	904	"	.117	.117	-.010
"	"	Cult. 5 yrs.	907	"	.111		
"	"	"	910	"	.107	.109	-.018
Debolt	H.C.L.	Virgin	794	0-6	.279		
"	"	"	798	"	.276	.278	
"	"	Cult. 20 yrs.	801	"	.311		
"	"	"	804	"	.298	.305	+.027
"	"	Cult. 6 yrs.	807	"	.283		
"	"	"	810	"	.280	.282	+.004
"	"	Virgin	795	6-12	.094		
"	"	"	799	"	.104	.099	
"	"	Cult. 20 yrs.	802	"	.104		
"	"	"	805	"	.101	.103	+.004
"	"	Cult. 6 yrs.	808	"	.093		
"	"	"	811	"	.093	.093	-.006
Debolt	C.	Virgin	796	12-24	.097		
"	"	"	800	"	.082	.088	
"	"	Cult. 20 yrs.	803	"	.085		
"	"	"	806	"	.090	.088	±.000
"	"	Cult. 6 yrs.	809	"	.098		
"	"	"	812	"	.095	.097	+.009

acre. In the 6 to 12 inch depth, however, only one loss occurred (at Debolt) giving an average gain, in this case, of 180 pounds per acre of nitrogen. For the other depths Nampa only shows losses while corresponding figures are not presented for the Debolt samples. The total loss or gain to the depth analyzed is given in the extreme right hand column of Table 11.

Table 11. Loss or gain of nitrogen in cultivated gray transition soils on a pounds per acre basis

	Depth in inches				Total gain or loss
Location	0-6	6-12	12-18	18-24	
Nampa	-3,492	+234	-180	-180	-3,618
"	-3,042	+522	-324	-324	-3,168
Debolt	+486	+72			+558
"	+72	-108	+162		+126
Average gain or loss	-1,494	+180	-114	-252	

Gray Soils

The results for total nitrogen in virgin and cultivated gray soils are presented in Tables 12 and 13.

The data in Table 12 are given in percentage figures. In the surface layers of cultivated samples losses occur in all nine instances ranging from .003% to .047% nitrogen or an average of .022% nitrogen. In the subsurface layer losses

Table 12. Total nitrogen in virgin and cultivated gray soils and loss or gain of nitrogen in cultivated soil

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
MacKay	Si.L.	Virgin	591	0-7	.204		
"	"	"	594	"	.181	.193	
"	"	Cult. 14 yrs.	597	"	.202		
"	"	"	600	"	.177	.190	-.003
"	C.	Virgin	592	7-14	.048		
"	"	"	595	"	.044	.046	
"	"	Cult.	598	"	.048		
"	"	"	601	"	.047	.048	+.002
"	"	Virgin	593	14-36	.045		
"	"	"	596	"	.041	.043	
"	"	Cult.	599	"	.047		
"	"	"	602	"	.041	.044	+.001
Gunn	L.	Virgin	633	0-7	.174		
"	"	"	636	"	.187	.181	
"	"	Cult. 11 yrs.	639	"	.162		
"	"	"	642	"	.148	.155	-.026
"	C.L.	Virgin	634	7-14	.049		
"	"	"	637	"	.050	.050	
"	"	Cult.	640	"	.044		
"	"	"	643	"	.041	.043	-.007
"	C.	Virgin	635	14-36	.045		
"	"	"	638	"	.042	.044	
"	"	Cult.	641	"	.045		
"	"	"	644	"	.038	.042	-.002
Goodfare	Si.L.	Virgin	818	0-8	.173		
"	"	"	822	"	.158	.166	
"	"	Cult. 22 yrs.	825	0-6	.136		
"	"	"	828	"	.143	.140	-.026
"	C.	Virgin	819	8-14	.093		
"	"	"	823	"	.093	.093	
"	"	Cult.	826	6-12	.103		
"	"	"	829	"	.096	.100	+.007
"	"	Virgin	820	14-25	.100		
"	"	"	824	"	.104	.102	
"	"	Cult.	827	12-24	.101		
"	"	"	830	"	.108	.105	+.003

Table 12 (continued)

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Breton	Si.L.	Virgin	661	0-7	.140		
"	"	"	664	"	.162	.151	
"	"	Cult. E-1	667	"	.108		
"	"	"	670	"	.103	.106	-.045
"	C.	Virgin	662	7-14	.048		
"	"	"	665	"	.045	.047	
"	"	Cult.	668	"	.049		
"	"	"	671	"	.045	.047	±.000
"	"	Virgin	663	14-36	.035		
"	"	"	666	"	.034	.035	
"	"	Cult.	669	"	.034		
"	"	"	672	"	.030	.032	-.003
Breton	Si.L.	Virgin	661	0-7	.140		
"	"	"	664	"	.162	.151	
"	"	Cult. E-3	673	"	.103		
"	"	"	676	"	.104	.104	-.047
"	C.	Virgin	662	7-14	.048		
"	"	"	665	"	.045	.047	
"	"	Cult.	674	"	.044		
"	"	"	677	"	.046	.045	-.002
"	"	Virgin	663	14-36	.035		
"	"	"	666	"	.034	.035	
"	"	Cult.	675	"	.041		
"	"	"	678	"	.028	.035	±.000
Breton	Si.L.	Virgin	681	0-7	.118		
"	"	"	684	"	.108	.113	
"	"	Cult. 15 yrs.	687	"	.108		
"	"	"	690	"	.112	.110	-.003
"	C.	Virgin	682	7-14	.041		
"	"	"	685	"	.041	.041	
"	"	Cult.	688	"	.045		
"	"	"	691	"	.044	.045	+.004
"	"	Virgin	683	14-36	.034		
"	"	"	686	"	.025	.030	
"	"	Cult.	689	"	.033		
"	"	"	692	"	.030	.032	+.002

Table 12 (continued)

					Total N%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Cherhill	L.	Virgin	647	0-7	.133		
"	"	"	650	"	.136	.135	
"	"	Cult. 11 yrs.	653	"	.120		
"	"	"	656	"	.123	.122	-.013
"	C.	Virgin	648	7-14	.044		
"	"	"	651	"	.047	.046	
"	"	Cult.	654	"	.056		
"	"	"	657	"	.059	.058	+.012
"	"	Virgin	649	14-36	.041		
"	"	"	652	"	.041	.041	
"	"	Cult.	655	"	.053		
"	"	"	658	"	.044	.049	+.008
Carrot Creek	Si.L.	Virgin	605	0-7	.142		
	"	"	608	"	.137	.140	
"	"	Cult. 5 yrs.	611	"	.117		
"	"	"	614	"	.118	.118	-.022
"	C.	Virgin	606	7-14	.052		
"	"	"	609	"	.051	.052	
"	"	Cult.	612	"	.048		
"	"	"	615	"	.055	.052	±.000
"	"	Virgin	607	14-36	.056		
"	"	"	610	"	.053	.055	
"	"	Cult.	613	"	.058		
"	"	"	616	"	.062	.060	+.005
Edson	Si.L.	Virgin	619	0-7	.083		
"	"	"	622	"	.084	.084	
"	"	Cult. 25 yrs.	625	"	.067		
"	"	"	628	"	.066	.067	-.017
"	C.	Virgin	620	7-14	.048		
"	"	"	623	"	.049	.049	
"	"	Cult.	626	"	.051		
"	"	"	629	"	.048	.050	+.001
"	"	Virgin	621	14-36	.027		
"	"	"	624	.034	.031		
"	"	Cult.	627	"	.028		
"	"	"	630	"	.024	.026	-.005

occur in only two cases while gains occur in five instances; two locations show neither a gain or loss. The average for the nine is a gain of .002%, an insignificant figure. While the subsoils show that losses occur in two cases and gains in five cases, the differences are too small to be of much significance. The average is practically negligible, being only a gain of .001% nitrogen.

Table 13. Loss or gain of nitrogen in cultivated gray soils on a pounds per acre basis

Location	Depth in inches				Total gain or loss
	0-6	6-12	12-18	18-24	
MacKay	-54	+21	+24	+54	+45
Gunn	-468	-183	-66	-108	-825
Goodfare	-468	-312	+108	+54	-618
Breton E-1	-810	-135	-36	-162	-1,143
" E-3	-846	-171	-12		-1,029
"	-54	+51	+48	+108	+153
Cherhill	-234	+141	+168	+432	+507
Carrot Creek	-396	-66	+60	+270	+132
Edson	-306	-36	-54	-270	-666
Av. gain or loss	-404	-77	+27	+47	

More accurate comparisons are presented in Table 13 where the results are given on a pounds per acre basis for each 6-inch depth. The first 6-inch depth shows that in all nine cases losses occur and that the average loss is 404 pounds of nitrogen per acre or 15% of the original nitrogen present. In the 6 to 12 inch depth, three locations show gains while six show losses. The average for this depth is only a loss of 77 pounds per acre. The 12 to 18 inch depth shows losses in

Table 14. Loss or gain of nitrogen (pounds per acre) in the first and second 6-inch depths showing a comparison of the effects of length of time cultivated

Location	Soil class	Yrs. cult.	Depth in inches 0-6	Depth in inches 6-12	Total gain or loss	Yrs. cult.	Depth in inches 0-6	Depth in inches 6-12	Total gain or loss
Lloydminster	L.	30	-2,700	-1,590	-4,290	5	-684	-1,014	-1,698
Vegreville	L.	30	-1,582	-72	-1,654	10	+828	+888	+1,716
Pincher Creek	Si.L.	27	-3,222	-507	-3,729	13	-4,104	-1,728	-5,832
Parkland	L.	27	-2,952	-648	-3,600	10	-288	-54	-342
Edgerton	L.	26	-540	-42	-582	12	-1,692	+18	-1,674
Morrin	C.	26	-1,584	+108	-1,476	13	-486	-648	-1,134
Hand Hills	L.	20	-168	+122	-46	9	-1,692	+180	-1,512
Lethbridge	Si.L.	27*	-1,368	+126	-1,242	8**	+252	+558	+810
Gros Ventre	L.	20	-1,890	-594	-2,484	9	-2,268	-18	-2,276
Cavendish	F.S.L.	23	-441	+234	-207	11**	+108	+522	+630
Brooks	L.	12	-1,044	-414	-1,458	3	-396	+270	-126
High Prairie	C.L.	30	-6,990	-270	-7,260	11	-1,980	-855	-2,835
Nampa	C.L.	20	-3,492	+234	-3,258	5	-3,042	+522	-2,520
Debolt	H.C.L.	20	+486	+72	+558	6	+72	-108	-36
Fairview	Si.L.	29	-4,824	-1,314	-6,138	12	-3,636	-504	-4,140
Average		24	-2,154	-304	-2,458	9	-1,267	-51	-1,318

* Number of years not known definitely, approximately 25-30.

** Belongs to the loam class of soil.

only four cases while gains occur in five out of the nine locations. The average in this layer is only a gain of 27 pounds per acre, too small to be of any significance. In the next depth, 18 to 24 inches, losses occur in only three instances, gains in five, with an average gain of 47 pounds per acre.

Again the total loss or gain to the depth analyzed is given in the extreme right hand column of Table 13.

Effect of Length of Time of Cultivation on Nitrogen Losses

An attempt has been made to get at the question of the effect of length of time of cultivation on nitrogen losses by sampling recently broken fields as well as fields cultivated for longer periods of time.

In Table 14 the various locations so sampled have been grouped for purposes of comparison. The location is given, the soil class, number of years cultivated and the pounds per acre loss of nitrogen for the first two 6-inch depths. These represent results from composite samples while below these depths for the most part only single samples were taken. It was felt that only the two upper layers could be used in this comparison. It will be noticed that the table is divided practically in half with the figures for the older cultivated fields on the left, and those for the more recently broken fields on the right. Totals for the depth

indicated are shown. Average figures are also shown.

Accurate comparisons are rather difficult from this table due to the fact that the number of years cultivated varies so much. However, there are a few points of interest to be found from a study of this table. On the left side of the table for the 0 to 6 inch depth only one gain is shown; all the other 14 locations show losses of nitrogen. On the right hand side, however, four locations show gains while eleven show losses of nitrogen.

Pincher Creek results show that in 13 years evidently the cultivated soil has lost over 4,000 pounds of nitrogen per acre, while in 27 years the cultivated has apparently only lost something over 3,000 pounds of nitrogen per acre.

Edgerton and Hand Hills cultivated samples also appear to have lost more nitrogen in a few years than over a longer period of cultivation.

However, the results from many locations indicate that the loss of nitrogen has taken place in a more or less progressive fashion. Such is the case for Lloydminster, Parkland, Morrin, Brooks and High Prairie. The analyses of samples from at least two locations indicate a rather rapid loss in the first few years of cultivation, with not much change thereafter; these are Nampa and Fairview.

For the older cultivated fields the average number of years cultivated is 24 with an average loss of 2,154 pounds in the first 6-inch depth and 304 pounds for the second depth. The average number of years cultivated for the recently broken

fields is nine years with an average loss of 1,267 pounds for 0 to 6 inches and 51 pounds for the 6 to 12 inch depth.

Organic Carbon Results

The results of the organic carbon determinations for virgin and cultivated soils previously presented in Table 1 have been rearranged according to zones and given in Tables 15 to 27. Each soil zone, as for nitrogen, will be dealt with separately.

Black Soils

The organic carbon results for comparable virgin and cultivated black soils are presented in Tables 15 and 16.

Table 15 gives the data on a percentage basis and indicates the gain or loss in percent. The soil class, number of years cultivated and depth are also given in this table. Only three out of fourteen locations show gains in the surface layer, these being only 0.63%, 0.48% and 0.43% organic carbon for Lacombe, Vegreville and Winkler respectively. The other eleven locations show losses ranging from 0.25% to 3.12% organic carbon. The average loss amounts to 1.22% organic carbon from the surface cultivated soils.

In the subsurface or second layer four locations show gains of organic carbon in the cultivated over the virgin samples; these range from 0.02% carbon to 0.50% carbon. Ten out of fourteen instances show losses of organic carbon ranging from 0.01% to 0.96% carbon. The average for all locations

Table 15. Total organic carbon in virgin and cultivated black soils and loss or gain of organic carbon in cultivated soil

					Total organic C%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Lloydminster	L.	Virgin	469	0-8	7.29		
"	"	"	471	"	6.29	6.79	
"	"	Cult. 30 yrs.	345*	0-7	5.03		
"	"	"	348*	"	5.11	5.07	-1.72
"	Si.L.	Virgin	470	8-11	1.36		
"	"	"	472	"	1.45	1.41	
"	"	Cult.	346*	7-11	1.31		
"	"	"	349*	"	1.88	1.60	+.19
Lloydminster	L.	Virgin	577	0-7	7.17		
"	"	"	580	"	7.41	7.29	
"	"	Cult. 5 yrs.	583	"	6.65		
"	"	"	586	"	6.43	6.54	-.75
"	Si.L.	Virgin	578	7-14	2.02		
"	"	"	581	"	2.08	2.05	
"	"	Cult.	584	"	1.32		
"	"	"	587	"	1.30	1.31	-.74
"	C.L.	Virgin	579	14-20	0.60		
"	"	"	582	"	0.58	0.59	
"	"	Cult.	585	"	0.54		
"	"	"	588	"	0.51	0.53	-.06
Lacombe	L.	Virgin	567	0-6	4.81		
"	"	"	569	"	5.44	5.13	
"	"	Cult. 26 yrs.	451*	"	5.79		
"	"	Rot. 0	454*	"	5.72	5.76	+.63
"	C.L.	Virgin	568	6-15	3.27		
"	"	"	570	"	3.20	3.24	
"	"	Cult.	452*	"	3.45		
"	"	"	455*	"	3.81	3.63	+.39
Vegreville	L.	Virgin	276**	0-8	5.39		
"	"	"	280**	"	5.60	5.50	
"	"	Cult. 10 yrs.	571	"	5.96		
"	"	"	574	"	6.00	5.98	+.48
"	"	Cult. 30 yrs.	284**	0-6	5.31		
"	"	"	288**	"	5.18	5.25	-0.25
"	C.L.	Virgin	278**	8-26	1.08		
"	"	"	282**	8-34	0.72	0.90	
"	"	Cult. 10 yrs.	572	8-14	1.52		

* Figures obtained from Caldwell's thesis (1938); virgin soil at Lloydminster and Lacombe resampled in 1938.

** Figures obtained from Caldwell's thesis (1938) to give a comparison of older and newer fields.

Table 15 (continued)

					Total organic C%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Vegreville	C.L.	Cult. 10 yrs.	575	"	1.28	1.40	+0.50
"	"	Cult. 30 yrs.	286*	6-26	0.85		
"	"	"	290*	6-27	0.99	0.92	+0.02
"	"	Cult. 10 yrs.	573	14-20	0.80		
"	"	"	576	"	0.71	0.76	-0.14
Pincher Creek	Si.L.	Virgin	121*	0-7	8.01		
"	"	"	125*	"	7.93	7.97	
"	"	Cult. 27 yrs.	129*	"	4.91		
"	"	"	133*	"	5.04	4.98	-2.99
"	C.	Virgin	123*	7-22	1.72		
"	"	"	127*	"	1.33	1.53	
"	"	Cult.	131*	"	1.40		
"	"	"	135*	"	1.63	1.52	-0.01
Pincher Creek	Si.L.	Virgin	775	0-8	7.36		
"	"	"	779	"	6.69	7.03	
"	"	Cult. 13 yrs.	781	"	3.77		
"	"	"	783	"	4.05	3.91	-3.12
"	C.	Virgin	776	8-18	1.66		
"	"	"	780	"	1.64	1.65	
"	"	Cult.	782	"	1.05		
"	"	"	784	"	1.07	1.06	-0.59
Parkland	L.	Virgin	137*	0-6	6.03		
"	"	"	141*	"	5.68	5.86	
"	"	Cult. 27 yrs.	145*	"	3.39		
"	"	"	149*	"	3.27	3.33	-2.53
"	C.L.	Virgin	139*	6-20	1.67		
"	"	"	143*	6-16	3.09	2.38	
"	"	Cult.	147*	6-14	1.78		
"	"	"	151*	6-13	1.89	1.84	-0.54
Parkland	L.	Virgin	785	0-6	4.31		
"	"	"	788	"	4.11	4.21	
"	"	Cult. 10 yrs.	790	"	3.90		
"	"	"	792	"	3.82	3.86	-0.35
"	Si.L.	Virgin	786	6-15	1.59		
"	"	"	789	"	1.56	1.58	
"	"	Cult.	791	"	1.56		
"	"	"	793	"	1.48	1.52	-0.06

* Figures obtained from Caldwell's thesis (1938) to give a comparison of older and newer fields.

Table 15 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Total organic C%		
						Av. of duplicates	Gain or loss
Yorkton	L.	Virgin	481	0-7	5.82		
"	"	"	484	"	5.77	5.80	
"	"	Cult. 40 yrs.	487	"	4.55		
"	"	"	489	"	4.54	4.55	-1.25
"	Si.L.	Virgin	482	7-15	2.33		
"	"	"	485	"	1.86	2.10	
"	"	Cult.	488	"	1.85		
"	"	"	490	7-13	2.07	1.96	-0.14
Brandon	F.S.L.	Virgin	501	0-7	5.78		
"	"	"	504	"	5.93	5.86	
"	"	Cult. 50 yrs.	507	"	3.82		
"	"	"	509	"	3.93	3.88	-1.98
"	"	Virgin	502	7-17	2.02		
"	"	"	505	"	1.99	2.01	
"	"	Cult.	508	"	1.82		
"	"	"	510	"	1.83	1.83	-0.18
Portage La Prairie	Si.L.	Virgin	511	0-8	5.33		
"	"	"	514	"	5.43	5.38	
"	"	Cult. 50 yrs.	517	"	4.34		
"	"	"	519	"	4.31	4.33	-1.05
"	"	Virgin	512	8-20	2.33		
"	"	"	515	"	2.33	2.33	
"	"	Cult.	518	8-17	2.04		
"	"	"	520	"	2.00	2.02	-0.31
Selkirk	C.L.	Virgin	521	0-8	8.92		
"	"	"	525	"	9.00	8.96	
"	"	Cult. 35 yrs.	529	"	6.42		
"	"	"	531	"	6.17	6.30	-2.66
"	C.	Virgin	522	8-18	2.77		
"	"	"	526	"	2.78	2.78	
"	"	Cult.	530	8-20	2.15		
"	"	"	532	"	2.21	2.18	-0.60
Winkler	L.	Virgin	533	0-7	3.11		
"	"	"	538	"	3.28	3.20	
"	"	Cult. 50 yrs.	543	"	3.74		
"	"	"	545	"	3.52	3.63	+0.43
"	"	Virgin	534	7-17	4.36		
"	"	"	539	"	4.34	4.35	
"	"	Cult.	544	"	3.41		
"	"	"	546	"	3.37	3.39	-0.96

is a loss of 0.22% organic carbon in this layer.

From the figures on a pounds per acre basis (Table 16), only three out of fourteen locations show gains of organic carbon, ranging from 7,740 pounds to 11,340 pounds for the surface 6-inch depth. For the eleven losses the range is from 6,300 pounds to 55,960 pounds per acre. The average for all locations for the 0 to 6 inch depth is a loss of 23,363 pounds of organic carbon per acre. This is equal to a loss of 40,278 pounds of organic matter.

Table 16. Loss or gain of organic carbon in cultivated black soils on a pounds per acre basis

	Depth in inches			Total organic carbon	Total organic matter
	0-6	6-12	12-18		
Lloydminster	-30,960	-19,020		-49,980	-86,165
"	-13,500	-13,350	-5,160	-32,010	-55,185
Lacombe	+11,340	+7,020		+18,360	+31,653
Vegreville	-23,982	-7,754	+360	-31,376	-54,092
"	+8,640	+8,880		+17,520	+30,204
Pincher Creek	-53,820	-9,120	-180	-63,120	-108,819
" "	-55,960	-25,800	-10,620	-92,380	-159,263
Parkland	-45,540	-9,810		-55,350	-95,423
"	-6,300	-1,080		-7,380	-12,723
Yorkton	-22,500	-5,850		-28,350	-48,875
Brandon	-35,640	-8,640	-2,700	-46,980	-80,993
P. La Prairie	-18,720	-9,960	-5,580	-34,260	-59,064
Selkirk	-47,880	-23,160	-10,800	-81,840	-140,092
Winkler	+7,740	-13,110	-14,400	-19,770	-34,083
Average loss or gain in carbon	-23,363	-9,340	-6,135		
Average loss or gain in organic matter	-40,278	-16,102	-10,577		

In the second 6-inch depth two out of fourteen locations show gains of 7,020 pounds and 8,880 pounds of organic carbon per acre. The twelve losses range from 1,080 pounds to 25,800 pounds per acre of carbon. The average loss for the 6 to 12 inch depth amounts to 9,340 pounds of carbon per acre or an average of 16,102 pounds of organic matter.

In the third 6-inch depth there are only eight figures given; one shows a gain, the other seven reveal losses. On the average this layer has apparently lost 6,135 pounds of carbon or 10,577 pounds of organic matter.

The two columns at the right-hand side of the table give the total loss or gain of organic carbon to the depth indicated and also the total loss or gain of organic matter to the depth shown. Organic matter is calculated by multiplying the organic carbon by the factor 1.724.

Dark Brown Soils

A comparison of organic carbon in virgin and cultivated dark brown soils is presented in Tables 17 and 18.

In Table 17 nine out of eleven locations show losses of organic carbon in the cultivated surface samples ranging from 0.27% to 2.21%. The only two gains are at Hand Hills and Lethbridge and these figures are of a low order, 0.05% and 0.04% carbon respectively. The average of the eleven figures is a loss of 0.95% organic carbon from the surface layer of dark brown soils.

In the subsurface layer losses occur at five locations and gains at six locations. The losses vary from 0.08% to 0.51%

Table 17. Total organic carbon in virgin and cultivated dark brown soils and loss or gain of organic carbon in cultivated soil

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Total organic C%		
						Av. of duplicates	Gain or loss
Waskada	L.	Virgin	547	0-6	5.28		
"	"	"	550	"	5.14	5.21	
"	"	Cult. 30 yrs.	553	"	3.67		
"	"	"	555	"	3.81	3.74	-1.47
"	"	Virgin	548	6-13	2.74		
"	"	"	551	"	3.03	2.89	
"	"	Cult.	554	6-12	2.82		
"	"	"	556	"	3.16	2.99	+0.10
Edgerton	L.	Virgin	292[*]	0-8	4.46		
"	"	"	296[*]	"	3.95	4.21	
"	"	Cult. 26 yrs.	300[*]	"	3.18		
"	"	"	303[*]	"	3.65	3.42	-0.79
"	Si.L.	Virgin	294[*]	8-17	1.27		
"	"	"	298[*]	8-21	1.30	1.29	
"	"	Cult.	301[*]	8-20	1.14		
"	"	"	305[*]	"	1.16	1.15	-0.14
Edgerton	L.	Virgin	693	0-7	5.46		
"	"	"	697	"	5.53	5.50	
"	"	Cult. 12 yrs.	700	"	4.13		
"	"	"	703	"	4.13	4.13	-1.37
"	Si.L.	Virgin	694	7-12	1.59		
"	"	"	698	"	1.56	1.58	
"	"	Cult.	701	"	1.66		
"	"	"	704	"	1.70	1.68	+0.10
"	C.	Virgin	695	12-23	0.89		
"	"	"	699	"	0.82	0.86	
"	"	Cult.	702	"	1.20		
"	"	"	705	"	0.86	1.03	+0.17
Morrin	C.	Virgin	457[*]	0-6	5.02		
"	"	"	460[*]	"	4.78	4.90	
"	"	Cult. 26 yrs.	463[*]	"	3.46		
"	"	"	466[*]	"	3.41	3.44	-1.46
"	"	Virgin	458[*]	6-12	2.25		
"	"	"	461[*]	"	2.09	2.17	
"	"	Cult.	464[*]	"	2.22		
"	"	"	467[*]	"	1.93	2.08	-0.09

[*] See footnote page 61.

Table 17 (continued)

					Total organic C%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Morrin	C.	Virgin	706	0-6	3.54		
"	"	"	709	"	3.65	3.60	
"	"	Cult. 13 yrs.	712	"	2.92		
"	"	"	715	"	3.22	3.07	-0.53
"	"	Virgin	707	6-12	2.11		
"	"	"	710	"	2.28	2.20	
"	"	Cult.	713	"	1.75		
"	"	"	716	"	1.69	1.72	-0.48
"	"	Virgin	708	12-22	1.36		
"	"	"	711	"	1.71	1.54	
"	"	Cult.	714	"	1.02		
"	"	"	717	"	1.21	1.12	-0.42
Hand Hills	L.	Virgin	17*	0-8	2.65		
"	"	"	20*	"	3.10	2.88	
"	"	Cult. 20 yrs.	23*	0-6	3.16		
"	"	"	26*	0-8	2.69	2.93	+0.05
"	C.L.	Virgin	18*	8-14	1.35		
"	"	"	21*	"	1.33	1.34	
"	"	Cult.	24*	6-12	1.60		
"	"	"	27*	8-14	1.34	1.47	+0.13
Hand Hills	L.	Virgin	718	0-6	4.63		
"	"	"	722	"	4.77	4.70	
"	"	Cult. 9 yrs.	725	"	3.32		
"	"	"	728	"	3.10	3.21	-1.49
"	C.L.	Virgin	719	6-12	1.30		
"	"	"	723	"	1.15	1.23	
"	"	Cult.	726	"	1.37		
"	"	"	729	"	1.42	1.40	+0.17
"	"	Virgin	720	12-18	1.03		
"	"	"	724	"	1.00	1.02	
"	"	Cult.	727	"	1.57		
"	"	"	730	"	0.89	1.23	+0.21

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* See footnote page 61.

Table 17 (continued)

					Total organic C%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Leth-bridge	Si.L.	Virgin	439[*]	0-6	2.60		
"	"	"	442[*]	"	2.52	2.56	
"	"	Cult. Rot.C (Dry land)	445[*]	"	1.60		
"	"		448[*]	"	1.52	1.56	-1.00
"	"	Virgin	440[*]	6-18	1.20		
"	"	"	443[*]	"	1.16	1.18	
"	"	Cult.	446[*]	6-12	1.07		
"	"	"	449[*]	"	1.30	1.19	+0.01
Leth-bridge	L.	Virgin	766	0-6	2.57		
	"	"	769	"	2.49	2.53	
"	"	Cult. 8 yrs.	771	"	2.57		
"	"	"	773	"	2.57	2.57	+0.04
"	Si.L.	Virgin	767	6-12	1.20		
"	"	"	770	"	1.19	1.20	
"	"	Cult.	772	6-11	1.47		
"	"	"	774	"	1.53	1.50	+0.30
Estevan	L.	Virgin	557	0-6	4.44		
"	"	"	560	"	4.63	4.54	
"	"	Cult. 35 yrs.	563	"	2.30		
"	"	"	565	"	2.35	2.33	-2.21
"	C.L.	Virgin	558	6-14	1.20		
"	"	"	561	"	1.17	1.19	
"	"	Cult.	564	6-18	0.68		
"	"	"	566	"	0.67	0.68	-0.51
"	"	Virgin	559	14-18	0.85		
"	"	"	562	"	0.76	0.81	
Hanley	L.	Virgin	473	0-7	2.25		
"	"	"	475	"	2.19	2.22	
"	"	Cult. 30 yrs.	477	"	1.88		
"	"	"	479	"	2.01	1.95	-0.27
"	Si.L.	Virgin	474	7-15	0.72		
"	"	"	476	"	0.87	0.80	
"	"	Cult.	478	"	0.65		
"	"	"	480	"	0.78	0.72	-0.08

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[*] See footnote page 61.

carbon while the gains range from 0.01% to 0.30% carbon. The average is a loss of only 0.04% organic carbon for this layer.

Only a few figures are given for lower depths and these are of a low order. The Morrin sample shows the highest figure in the deeper layer, where the loss of organic carbon amounts to 0.42% in the cultivated soil.

Table 18. Loss or gain of organic carbon in cultivated dark brown soils on a pounds per acre basis

	Depth in inches			Total organic carbon	Total organic matter
Location	0-6	6-12	12-18		
Waskada	-26,460	+1,800		-25,660	-44,238
Edgerton	-14,220	-5,370	-945	-20,535	-35,402
"	-24,660	-2,610	+3,060	-24,210	-41,738
Morrin	-26,370	-1,710		-28,080	-48,410
"	-9,540	-8,640	-7,560	-25,740	-44,376
Hand Hills	+900	+1,860		+2,760	+4,758
" "	-26,820	+3,060	+3,780	-19,980	-34,445
Lethbridge	-18,000	+180		-17,820	-30,722
"	+720	+5,400		+6,120	+10,551
Estevan	-39,780	-9,180	-4,620	-53,580	-92,372
Hanley	-4,860	-2,010		-6,870	-11,844
Av. gain or loss in carbon	-17,190	-1,565	-1,257		
Av. gain or loss in organic matter	-30,036	-2,698	-2,167		

As before, the pounds per acre basis (Table 18) reveals the comparisons more accurately. The two gains, Hand Hills and Lethbridge, are only 900 pounds and 720 pounds of organic carbon in the 0 to 6 inch depth. The losses in this depth range from 4,860 pounds to 39,780 pounds per acre. The average loss for

eleven locations amounts to 17,190 pounds of organic carbon or 30,036 pounds of organic matter.

In the 6 to 12 inch depth there are six losses ranging from 1,710 pounds to 9,180 pounds of organic carbon per acre and five gains varying from 180 pounds to 5,400 pounds. The average loss, in this case, is 1,565 pounds of organic carbon or 2,698 pounds of organic matter.

For the next depth, 12 to 18 inches, only five figures are given, two of which are gains and three losses. The average for those figures given is a loss of 1,257 pounds of organic carbon or 2,167 pounds of organic matter.

Again at the right hand side of the table may be found two columns presenting the total loss or gain of organic carbon and total loss or gain of organic matter (calculated from the carbon) to the depth indicated.

Brown Soils

The results for organic carbon in brown soils may be found in Tables 19 and 20.

Considering Table 19, losses occur in all surface horizons, varying from 0.40% to 1.93% organic carbon or an average of 0.94% carbon. In the subsurface layer losses vary from 0.05% to 0.35% carbon in three cases and from 0.08% to 0.13% carbon, or an average loss of only 0.04% organic carbon. Most of these figures for the second depth are of a low order and thus of doubtful significance. For the lower depth the figures that are given are likewise of a low order; one

Table 19. Total organic carbon in virgin and cultivated brown soils and loss or gain of organic carbon in cultivated soil

					Total organic C%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Gros Ventre	L.	Virgin	73[*]	0-6	4.14		
	"	"	77[*]	"	3.97	4.06	
"	"	Cult. 20 yrs.	81[*]	"	2.38		
"	"	"	85[*]	"	2.25	2.32	-1.74
"	C.L.	Virgin	75[*]	6-20	1.25		
"	"	"	79[*]	"	1.23	1.24	
"	"	Cult.	83[*]	"	0.89		
"	"	"	87[*]	6-24	0.89	0.89	-0.35
Gros Ventre	L.	Virgin	753	0-6	3.73		
	"	"	757	"	3.89	3.81	
"	"	Cult. 9 yrs.	760	"	1.89		
"	"	"	763	"	1.87	1.88	-1.93
"	C.L.	Virgin	754	6-12	0.94		
"	"	"	758	"	0.97	0.96	
"	"	Cult.	761	"	0.88		
"	"	"	764	"	0.89	0.89	-0.07
"	"	Virgin	755	12-21	0.93		
"	"	"	759	"	0.64	0.79	
"	"	Cult.	762	12-17	0.64		
"	"	"	765	"	0.70	0.67	-0.12
Cavendish	F.S.L.	Virgin	41[*]	0-5	2.01		
"	"	"	45[*]	"	1.83	1.92	
"	"	Cult. 23 yrs.	49[*]	"	1.45		
"	"	"	53[*]	"	1.20	1.33	-0.59
"	"	Virgin	43[*]	5-12	1.04		
"	"	"	47[*]	"	1.13	1.09	
"	"	Cult.	51[*]	"	1.19		
"	"	"	55[*]	"	0.89	1.04	-0.05
Cavendish	L.	Virgin	744	0-6	1.69		
"	"	"	747	"	1.79	1.74	
"	"	Cult. 11 yrs.	749	"	1.64		
"	"	"	751	"	1.71	1.68	-0.06
"	"	Virgin	745	6-14	0.82		
"	"	"	748	"	0.80	0.81	
"	"	Cult.	750	"	0.96		
"	"	"	752	"	0.91	0.94	+0.13

[*] See footnote page 61.

Table 19 (continued)

					Total organic C%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Brooks	F.S.L.	Virgin	1*	0-9	2.22		
"	"	"	5*	"	2.14	2.18	
"	"	(Cult. 12 yrs.	9*	"	1.35		
"	"	(Irrigated	13*	"	1.18	1.27	-0.91
"	"	Virgin	2*	9-16			
"	"	"	6*	"	0.81		
"	"	Cult.	10*	"	0.98		
"	"	"	14*	"	0.69	0.84	+0.03
"	"	Virgin	3*	16-36	0.55		
"	"	"	7*	"	0.59	0.57	
"	"	Cult.	11*	"	0.64		
"	"	"	15*	"	0.50	0.57	0.00
Brooks	L.	Virgin	731	0-6	3.64		
"	"	"	735	"	3.61	3.63	
"	"	(Cult. 3 yrs.	738	"	3.19		
"	"	(Irrigated	741	"	3.26	3.23	-0.40
"	Si.L.	Virgin	732	6-12	1.07		
"	"	"	736	"	1.04	1.06	
"	"	Cult.	739	"	1.15		
"	"	"	742	"	1.13	1.14	+0.08
"	"	Virgin	733	12-24	0.56		
"	"	"	737	"	0.40	0.48	
"	"	Cult.	740	"	0.59		
"	"	"	743	"	0.50	0.55	+0.07

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* See footnote page 61.

location (Brooks) shows neither a gain or loss in the 16 to 36 inch depth.

The magnitude of these losses is expressed on a pounds per acre basis in Table 20. It can easily be seen that in the surface 0 to 6 inches the losses vary from 1,080 pounds to 34,740 pounds per acre, or an average of 16,645 pounds of organic carbon. This amounts to a loss of some 28,696 pounds of organic matter from the surface layer of cultivated brown soils.

Table 20. Loss or gain of organic carbon in cultivated brown soils on a pounds per acre basis

	Depth in inches			Total organic carbon	Total organic matter
Location	0-6	6-12	12-18		
Gros Ventre	-31,320	-6,300	-6,300	-43,920	-75,718
" "	-34,740	-1,260	-2,160	-38,160	-65,788
Cavendish	-9,060	-810		-9,870	-17,016
"	-1,080	+2,340		+1,260	+2,172
Brooks	-16,470	-8,010	+300	-24,180	-41,686
"	-7,200	+1,440	+1,260	-4,500	-7,758
Av. gain or loss in carbon	-16,645	-2,100	-1,150		
Av. gain or loss in organic matter	-28,696	-3,620	-1,982		

In the 6 to 12 inch depth two locations have apparently gained in organic carbon by 2,340 pounds and 1,440 pounds per acre. The other four locations have evidently lost amounts of organic carbon varying from 810 pounds to 8,010 pounds per acre. There has been an average loss of 2,100 pounds of carbon

or 3,620 pounds of organic matter in the 6 to 12 inch depth for all locations.

At Gros Ventre in the 12 to 18 inch depth losses occur in both cases, being 6,300 pounds and 2,160 pounds of organic carbon per acre. However, at Brooks both locations show gains of 300 and 1,260 respectively. An average for the four locations gives a figure of 1,150 pounds loss of organic carbon or 1,982 pounds of organic matter.

The total loss or gain of organic carbon and organic matter is given in the two columns at the right of the table.

Black Transition Soils

The organic carbon results for the black transition zone are contained in Tables 21 and 22.

It will be noted in Table 21, where percentage figures are given, that there are only four locations that show gains in any horizon. These are Fairview with a gain of 0.05% carbon, Beaverlodge with a gain of only 0.01% carbon, Grande Prairie with a gain of 0.03% carbon, and Dauphin with a gain of 0.61% carbon. These all occur in the subsoil and the figures are of a low order. In the seven surface horizons the loss of organic carbon varies from 0.50% to 3.08% or an average of 2.40%. For the subsurface or second depth the variation in loss of carbon is from 0.13% to 0.52%. Dauphin shows a gain of 0.61% carbon for this layer; the average loss is 0.23% carbon. In the third layer there are three gains

Table 21. Total organic carbon in virgin and cultivated soils from the black transition zones and loss or gain of organic carbon in cultivated soil

					Total organic C%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
High Prairie	C.L.	Virgin	911	0-5	12.85		
"	"	"	915	"	13.50	13.18	
"	"	Cult. 30 yrs.	918	"	7.15		
"	"	"	921	"	6.95	7.05	-6.13
"	C.	Virgin	912	5-12	2.41		
"	"	"	916	"	2.12	2.27	
"	"	Cult.	919	"	1.99		
"	"	"	922	"	1.94	1.97	-0.30
"	"	Virgin	913	12-18	2.39		
"	"	"	917	"	2.02	2.21	
"	"	Cult.	920	"	1.79		
"	"	"	923	"	1.92	1.86	-0.35
High Prairie	C.L.	Virgin	924	0-7	11.86		
"	"	"	927	"	10.99	11.43	
"	"	Cult. 11 yrs.	930	"	8.81		
"	"	"	933	"	8.84	8.83	-2.60
"	C.	Virgin	925	7-14	1.83		
"	"	"	928	"	1.77	1.80	
"	"	Cult.	931	"	1.30		
"	"	"	934	"	1.29	1.30	-0.50
"	"	Virgin	926	14-20	1.34		
"	"	"	929	"	1.07	1.21	
"	"	Cult.	932	"	0.79		
"	"	"	935	"	0.95	0.87	-0.34
Fairview	Si.L.	Virgin	876	0-7	8.90		
"	"	"	880	"	9.19	9.05	
"	"	Cult. 29 yrs.	883	"	6.12		
"	"	"	886	"	5.81	5.97	-3.08
"	L.C.L.	Virgin	877	7-13	1.61		
"	"	"	881	"	1.72	1.67	
"	"	Cult.	884	"	1.22		
"	"	"	887	"	1.20	1.21	-0.46
"	C.	Virgin	878	13-30	1.09		
"	"	"	882	"	0.82	0.96	
"	"	Cult.	885	"	0.98		
"	"	"	888	"	1.04	1.01	+0.05

Table 21 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Total organic C%		
						Av. of duplicates	Gain or loss
Fairview	Si.L.	Virgin	863	0-6	8.45		
"	"	"	867	"	8.81	8.63	
"	"	Cult. 12 yrs.	870	"	5.64		
"	"	"	873	"	5.70	5.67	-2.97
"	C.L.	Virgin	864	6-12	1.97		
"	"	"	868	"	2.13	2.05	
"	"	Cult.	871	"	1.50		
"	"	"	874	"	1.55	1.53	-0.52
"	C.	Virgin	865	12-27	0.98		
"	"	"	869	"	1.26	1.12	
"	"	Cult.	872	"	0.96		
"	"	"	875	"	0.83	0.90	-0.22
Beaverlodge	L.C.L.	Virgin	850	0-6	7.16		
	"	"	854	"	7.48	7.32	
"	"	Cult. 22 yrs.	857	"	6.71		
"	"	"	860	"	6.49	6.60	-0.72
"	C.L.	Virgin	851	6-10	1.68		
"	"	"	855	"	1.75	1.72	
"	"	Cult.	858	"	1.43		
"	"	"	861	"	1.43	1.43	-0.29
"	C.	Virgin	852	10-(20 (26	1.27		
"	"	"	856	"	1.18	1.23	
"	"	Cult.	859	"	1.19		
"	"	"	862	"	1.29	1.24	+0.01
Grande Prairie	Si.L.	Virgin	831	0-6	4.08		
	"	"	835	"	4.10	4.09	
"	"	Cult. 25 yrs.	838	"	3.60		
"	"	"	841	"	3.57	3.59	-0 .50
"	L.C.	Virgin	832	6-12	1.24		
"	"	"	836	"	1.26	1.25	
"	"	Cult.	839	"	1.12		
"	"	"	842	"	1.12	1.12	-0.13
"	H.C.	Virgin	833	12-24	1.07		
"	"	"	837	"	1.11	1.09	
"	"	Cult.	840	12-26	1.10		
"	"	"	843	"	1.13	1.12	+0.03

Table 21 (continued)

					Total organic C%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Dauphin	H.C.L.	Virgin	491	0-8	7.31		
"	"	"	494	"	7.21	7.26	
"	"	Cult. 45 yrs.	497	"	6.46		
"	"	"	499	"	6.43	6.45	-0.81
"	C.L.	Virgin	492	8-16	4.24		
"	"	"	495	"	3.80	4.02	
"	"	Cult.	498	"	4.70		
"	"	"	500	"	4.56	4.63	+0.61

(mentioned above) and three losses. The losses range from 0.22 to 0.35%; the gains from 0.01% to 0.05%, or an average for the six locations of 0.14% loss of organic carbon.

In Table 21 comparable depths are not given, thus a better picture is presented in Table 22 where the losses and gains are on a pounds per acre basis for each 6-inch depth.

Table 22. Loss or gain of organic carbon in cultivated soils from the black transition zone on a pounds per acre basis

	Depth in inches			Total organic carbon	Total organic matter
Location	0-6	6-12	12-18		
High Prairie	-92,850	-5,400	-6,300	-104,550	-180,244
" "	-46,800	-15,300	-7,080	-69,180	-119,266
Fairview	-55,440	-16,140	-630	-72,210	-124,490
"	-53,460	-9,360	-3,960	-66,780	-115,129
Beaverlodge	-12,960	-5,220	+180	-18,000	-31,032
Grande Prairie	-9,000	-2,340	+540	-10,800	-18,619
Dauphin	-14,580	+2,460		-12,120	-20,895
Av. gain or loss in carbon	-40,727	-7,329	-2,875		
Av. gain or loss in organic matter	-70,213	-12,635	-4,956		

One outstanding figure is the surface 6-inch loss at High Prairie of 92,850 pounds per acre of organic carbon, or a total of 104,550 pounds for the first 18 inches. The seven locations show a variation from 9,000 pounds to 92,850 pounds loss of organic carbon in the surface six inches. This amounts to an average of 40,727 pounds of carbon or 70,213 pounds of organic matter. In the second 6-inch depth the variation of six losses

is from 2,340 pounds to 16,140 pounds (Dauphin showing a gain of 2,460 pounds), or an average loss of 7,329 pounds of carbon --12,635 pounds of organic matter. In the 12 to 18 inch depth two small gains of 180 and 540 pounds occur while the four losses range from 630 to 6,300 pounds of organic carbon per acre. The average for this last depth is -2,875 pounds of carbon or -4,956 pounds of organic matter.

As in previous tables the total loss or gain of organic carbon and organic matter is given in the two columns at the extreme right hand side of the table. Totals for organic carbon range from 10,800 to 104,550 pounds per acre. These are fairly large losses.

Gray Transition Soils

The results for organic carbon in gray transition soils are contained in Tables 23 and 24. Only two locations were sampled in this soil zone.

From Table 23 it is evident that at Nampa losses are shown of 2.64% and 3.09% in the surface layers; while at Debolt apparently there have been gains of 0.21% and 0.68% of organic carbon, or an average loss of 1.21%. In the subsurface layer Nampa shows one loss of only 0.01% and a gain of 0.26%, whereas Debolt shows one loss of 0.07% and a gain of 0.10% organic carbon. This gives an average gain of only 0.07% organic carbon for the subsurface layer. In the lowest depth analyzed the only loss shown is at Nampa (0.24% carbon). The average for this depth is a very small figure of 0.02% loss.

Table 23. Total organic carbon in virgin and cultivated gray transition soils and loss or gain of organic carbon in cultivated soil

					Total organic C%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Nampa	C.L.	Virgin	892	0-6	7.18		
"	"	"	896	"	7.32	7.25	
"	"	Cult. 20 yrs.	899	"	4.66		
"	"	"	902	"	4.56	4.61	-2.64
"	"	Cult. 5 yrs.	905	"	4.17		
"	"	"	908	"	4.15	4.16	-3.09
"	C.	Virgin	893	6-12	1.35		
"	"	"	897	"	1.23	1.29	
"	"	Cult. 20 yrs.	900	"	1.31		
"	"	"	903	"	1.25	1.28	-0.01
"	"	Cult. 5 yrs.	906	"	1.72		
"	"	"	909	"	1.37	1.55	+0.26
"	"	Virgin	894	12-32	0.85		
"	"	"	898	"	1.04	0.95	
"	"	Cult. 20 yrs.	901	"	0.99		
"	"	"	904	"	1.05	1.02	+0.07
"	"	Cult. 5 yrs.	907	"	0.73		
"	"	"	910	"	0.69	0.71	-0.24
Debolt	H.C.L.	Virgin	794	0-6	2.65		
"	"	"	798	"	2.64	2.65	
"	"	Cult. 20 yrs.	801	"	2.85		
"	"	"	804	"	2.86	2.86	+0.21
"	"	Cult. 6 yrs.	807	"	3.31		
"	"	"	810	"	3.35	3.33	+0.68
"	"	Virgin	795	6-12	0.81		
"	"	"	799	"	0.84	0.83	
"	"	Cult. 20 yrs.	802	"	0.93		
"	"	"	805	"	0.92	0.93	+0.10
"	"	Cult. 6 yrs.	808	"	0.81		
"	"	"	811	"	0.71	0.76	-0.07
"	C.	Virgin	796	12-24	0.84		
"	"	"	800	"	0.72	0.78	
"	"	Cult. 20 yrs.	803	"	0.87		
"	"	"	806	"	0.83	0.85	+0.07
"	"	Cult. 6 yrs.	809	"	0.71		
"	"	"	812	"	0.87	0.79	+0.01

This third depth is not very reliable due to the fact that only small amounts of carbon are present and also only single samples were taken. The two surface layers were composites.

The magnitude of the losses may be seen by an examination of Table 24. In the surface 6-inch depth there are two losses and two gains giving an average loss of organic carbon of 21,780 pounds for this layer or 37,549 pounds of organic matter. In the second 6-inch depth at Nampa one gain is shown and one loss, while at Debolt also one gain is shown and one loss. The average for this layer is a gain of 1260 pounds of organic carbon or 2,172 pounds of organic matter.

Table 24. Loss or gain of organic carbon in cultivated gray transition soils on a pounds per acre basis

	Depth in inches			Total organic carbon	Total organic matter
	0-6	6-12	12-18		
Nampa	-47,520	-180	+1,260	-46,440	-80,063
"	-55,620	+4,680	-4,320	-55,260	-95,268
Debolt	+3,780	+1,800	+1,260	+6,840	+11,792
"	+12,240	-1,260	+180	+11,160	+19,998
Av. gain or loss in carbon	-21,780	+1,260	-405		
Av. gain or loss in organic matter	-37,549	+2,172	-558		

For the 12 to 18 inch depth a loss is shown for only one location (Nampa). The average, however, is a loss of 405 pounds organic carbon or 558 pounds of organic matter. The loss of 4,320 pounds for Nampa appears somewhat out of line but -405, the

average figure given above, is decidedly small and thus of doubtful significance.

Total losses or gains of organic carbon and organic matter may be found in the two right hand columns of Table 24.

Gray Soils

The organic carbon results from nine locations in the gray soil zone are contained in Tables 25 and 26. While three separate fields were sampled at Breton each is referred to as a separate location.

In Table 25 it is of interest to note that losses have occurred at eight out of the nine locations in the surface layer, the only gain occurring at MacKay (+0.45% carbon). The range for the losses is from 0.08% to 1.42% carbon, or an average loss of 0.55% carbon in the surface layer. In the other layers the losses or gains are all very small, the highest being found at Goodfare (+0.17% carbon in 6 to 12 inches). These are not strictly comparable because of the difference in depths of cultivated and virgin samples.

A truer comparison may be found in Table 26. Here, as mentioned above, MacKay is the only location that shows a gain of organic carbon in the first 6-inch depth (8,100 pounds per acre). The losses range from 1,440 pounds to 25,560 pounds of organic carbon or an average of 9,960 pounds per acre. This amounts to 17,170 pounds of organic matter. In the second 6-inch depth MacKay is still the only location showing a gain (1,350 pounds). The losses range from 90 pounds to 6,840 pounds, or an average of 2,144 pounds of organic

Table 25. Total organic carbon in virgin and cultivated gray soils and loss or gain of organic carbon in cultivated soil

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Total organic C%		
						Av. of duplicates	Gain or loss
MacKay	Si.L.	Virgin	591	0-7	2.98		
"	"	"	594	"	2.50	2.74	
"	"	Cult. 14 yrs.	597	"	3.08		
"	"	"	600	"	3.29	3.19	+0.45
"	C.	Virgin	592	7-14	0.45		
"	"	"	595	"	0.44	0.45	
"	"	Cult.	598	"	0.45		
"	"	"	601	"	0.45	0.45	±0.00
"	"	Virgin	594	14-36	0.46		
"	"	"	596	"	0.42	0.44	
"	"	Cult.	599	"	0.48		
"	"	"	602	"	0.43	0.46	+0.02
Gunn	L.	Virgin	633	0-7	3.05		
"	"	"	636	"	3.33	3.19	
"	"	Cult. 11 yrs.	639	"	2.64		
"	"	"	642	"	2.62	2.63	-0.56
"	C.L.	Virgin	634	7-14	0.37		
"	"	"	637	"	0.51	0.44	
"	"	Cult.	640	"	0.41		
"	"	"	643	"	0.44	0.43	-0.01
"	C.	Virgin	635	14-36	0.37		
"	"	"	638	"	0.48	0.43	
"	"	Cult.	641	"	0.44		
"	"	"	644	"	0.37	0.41	-0.02
Goodfare	Si.L.	Virgin	818	0-8	2.54		
"	"	"	822	"	2.31	2.43	
"	"	Cult. 22 yrs.	825	0-6	1.69		
"	"	"	828	"	1.64	1.67	-0.76
"	C.	Virgin	819	8-14	0.77		
"	"	"	823	"	0.79	0.78	
"	"	Cult.	826	6-12	1.02		
"	"	"	829	"	0.87	0.95	+0.17
"	"	Virgin	820	14-25	1.03		
"	"	"	824	"	1.03	1.03	
"	"	Cult.	827	12-24	1.07		
"	"	"	830	"	1.01	1.04	+0.01

					Total organic C%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Breton	Si.L.	Virgin	661	0-7	2.70		
"	"	"	664	"	2.92	2.81	
"	"	Cult. E-1	667	"	1.41		
"	"	"	670	"	1.37	1.39	-1.42
"	C.	Virgin	662	7-14	0.51		
"	"	"	665	"	0.48	0.50	
"	"	Cult.	668	"	0.53		
"	"	"	671	"	0.52	0.53	+0.03
"	"	Virgin	663	14-36	0.36		
"	"	"	666	"	0.39	0.38	
"	"	Cult.	669	"	0.34		
"	"	"	672	"	0.36	0.35	-0.03
Breton	Si.L.	Virgin	661	0-7	2.70		
"	"	"	664	"	2.92	2.81	
"	"	Cult. E-3	673	"	1.45		
"	"	"	676	"	1.43	1.44	-1.37
"	C.	Virgin	662	7-14	0.51		
"	"	"	665	"	0.48	0.50	
"	"	Cult.	674	"	0.47		
"	"	"	677	"	0.49	0.48	-0.02
"	"	Virgin	663	14-36	0.36		
"	"	"	666	"	0.39	0.38	
"	"	Cult.	675	"	0.34		
"	"	"	678	"	0.32	0.33	-0.05
Breton	Si.L.	Virgin	681	0-7	2.32		
"	"	"	684	"	2.05	2.19	
"	"	Cult. 15 yrs.	687	"	1.75		
"	"	"	690	"	1.89	1.82	-0.37
"	C.	Virgin	682	7-14	0.41		
"	"	"	685	"	0.37	0.39	
"	"	Cult.	688	"	0.43		
"	"	"	691	"	0.44	0.44	+0.05
"	"	Virgin	683	14-36	0.42		
"	"	"	686	"	0.36	0.39	
"	"	Cult.	689	"	0.31		
"	"	"	692	"	0.30	0.31	-0.08

					Total organic C%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Cherhill	L.	Virgin	647	0-7	2.02		
"	"	"	650	"	2.23	2.13	
"	"	Cult. 11 yrs.	653	"	1.74		
"	"	"	656	"	1.73	1.74	-0.39
"	C.	Virgin	648	7-14	0.51		
"	"	"	651	"	0.49	0.50	
"	"	Cult.	654	"	0.53		
"	"	"	657	"	0.53	0.53	+0.03
"	"	Virgin	649	14-36	0.47		
"	"	"	652	"	0.50	0.49	
"	"	Cult.	655	"	0.52		
"	"	"	658	"	0.51	0.52	+0.03
Carrot Creek	Si.L.	Virgin	605	0-7	2.15		
"	"	"	608	"	1.95	2.05	
"	"	Cult. 5 yrs.	611	"	2.00		
"	"	"	614	"	1.93	1.97	-0.08
"	C.	Virgin	606	7-14	0.44		
"	"	"	609	"	0.41	0.43	
"	"	Cult.	612	"	0.44		
"	"	"	615	"	0.43	0.44	+0.01
"	"	Virgin	607	14-36	0.53		
"	"	"	610	"	0.52	0.53	
"	"	Cult.	613	"	0.56		
"	"	"	616	"	0.50	0.53	±0.00
Edson	Si.L.	Virgin	619	0-7	1.32		
"	"	"	622	"	1.31	1.32	
"	"	Cult. 25 yrs.	625	"	0.85		
"	"	"	628	"	0.83	0.84	-0.48
"	C.	Virgin	634	7-14	0.37		
"	"	"	637	"	0.51	0.44	
"	"	Cult.	640	"	0.41		
"	"	"	643	"	0.44	0.43	-0.01
"	"	Virgin	635	14-36	0.37		
"	"	"	638	"	0.48	0.43	
"	"	Cult.	641	"	0.44		
"	"	"	644	"	0.37	0.41	-0.02

carbon, or 3696 pounds of organic matter per acre. The largest difference for the third 6-inch depth occurs at Goodfare (+1,680 pounds). There are four locations showing gains and five showing losses, thus the average figure (29 pounds gain) is of practically no significance.

The total loss or gain of organic carbon and total loss or gain of organic matter is given in the two right hand columns of Table 26. The greatest loss has evidently occurred at Breton (E-1) where some 30,550 pounds of organic carbon have been lost in the first 18 inches under cultivation. Applications of complete fertilizer on E-3 plot at Breton evidently failed to maintain the organic carbon when continuous wheat was grown.

Table 26. Loss or gain of organic carbon in cultivated gray soils on a pounds per acre basis

	Depth in inches			Total organic carbon	Total organic matter
Location	0-6	6-12	12-18		
MacKay	+8,100	+1,350	+240	+9,690	+16,706
Gunn	-10,080	-1,830	-300	-12,210	-21,049
Goodfare	-13,680	-6,840	+1,680	-18,660	-32,170
Breton E-1	-25,560	-4,810	-180	-30,550	-52,668
" E-3	-24,660	-4,410	-720	-29,790	-51,358
Breton	-6,660	-360	-660	-7,680	-13,240
Cherhill	-7,020	-720	+540	-7,200	-12,413
Carrot Creek	-1,440	-90	+60	-1,470	-2,534
Edson	-8,640	-1,590	+300	-10,530	-18,154
Av. gain or loss in carbon	-9,960	-2,144	+29		
Av. gain or loss in organic matter	-17,170	-3,696	+50		

Effect of Length of Time of Cultivation on Losses of Organic Carbon

As in the case of nitrogen, an attempt has been made to determine the effect of length of time of cultivation on the organic carbon of the soils. A comparison of the organic carbon results for recently broken fields and older cultivated fields is given in Table 27.

The trends are similar to the nitrogen comparison previously given but the amounts are larger. The table is divided in two with the results for older cultivated fields on the left and the results for the more recently cultivated fields on the right. Figures for the first two 6-inch depths only are given since these are the most important ones in this work. The variation in number of years makes it difficult to obtain a good comparison. However, despite these facts, a few interesting points may be brought out from the table.

Results from several of the locations indicate a progressive loss of organic carbon over a long period of years, such as shown in the figures for Lloydminster, Parkland, Morrin, Brooks, and High Prairie. Pincher Creek is one outstanding exception to this progressive nature in that apparently the field cultivated for only 13 years has lost more organic carbon than the field cultivated for 27 years. Edgerton shows results similar to Pincher Creek, as does Hand Hills and Nampa. A few show very little difference in the amount of carbon lost over a short period as compared with

Table 27. Loss or gain of organic carbon (pounds per acre) in the first and second 6-inch depths showing a comparison of the effects of length of time cultivated

Location	Soil class	Yrs. cult.	Depth in inches		Total gain or loss	Yrs. cult.	Depth in inches		Total gain or loss
			0-6	6-12			0-6	6-12	
Lloydminster	L.	30	-30,960	-19,020	-49,980	5	-13,500	-13,350	-26,850
Vegreville	L.	30	-23,982	-7,754	-31,736	10	+8,640	+8,880	+17,520
Pincher Creek	Si.L.	27	-53,820	-9,120	-62,940	13	-55,960	-25,800	-81,760
Parkland	L.	27	-45,540	-9,810	-55,350	10	-6,300	-1,080	-7,380
Edgerton	L.	26	-14,220	-5,370	-19,590	12	-24,660	-2,610	-27,270
Morrin	C.	26	-26,370	-1,710	-28,080	13	-9,540	-8,640	-18,180
Hand Hills	L.	20	-2,610	-830	-3,440	9	-26,820	+3,060	-23,760
Lethbridge	Si.L.	27*	-18,000	+180	-17,820	8**	+720	+5,400	+6,120
Gros Ventre	L.	20	-31,320	-6,300	-37,620	9	-34,740	-1,260	-36,000
Cavendish	F.S.L.	23	-9,060	-810	-9,870	11**	-1,080	+2,340	+1,260
Brooks	L.	12	-16,470	-8,010	-24,480	3	-7,200	+1,440	-5,760
High Prairie	C.L.	30	-92,850	-5,400	-98,250	11	-46,800	-15,300	-62,100
Nampa	C.L.	20	-47,520	-180	-47,700	5	-55,620	+4,680	-50,940
Debolt	H.C.L.	20	+3,780	+1,800	+5,580	6	+12,240	-1,260	+10,980
Fairview	Si.L.	29	-55,440	-16,140	-71,580	12	-53,460	-9,360	-62,820
Average		24	-30,959	-7,898	-38,857	9	-20,939	-3,524	-24,463

* Number of years not definitely known, approximately 25-30.

** Belongs to loam class of soil.

the longer period, as in the case of Gros Ventre and Fairview. The results for Vegreville, Lethbridge and Debolt are rather irregular.

For the average of 24 years cultivated the loss of organic carbon has been 30,959 pounds per acre for the 0 to 6 inch depth, or a total loss of 38,857 pounds for the first foot. In the more recently broken fields the average period of cultivation is 9 years with an average loss of 20,939 pounds per acre for the 0 to 6 inch depth, and 3,524 pounds for the 6 to 12 inch depth or a total of 24,463 pounds for the first foot.

Carbon:Nitrogen Ratios

The carbon:nitrogen ratios have been calculated from the percentage nitrogen and carbon tables previously given. These are presented in Table 28 for virgin and cultivated surface, subsurface and subsoil horizons for the various soil zones.

From a study of this table it is evident that cultivation causes a narrowing of the carbon:nitrogen ratio. This does not only occur in the surface horizon but in most cases extends to the subsurface horizon while only in a few cases has the carbon:nitrogen ratio been narrowed in the subsoil. The carbon:nitrogen ratio also narrows from surface horizon down; this is most noticeable in the gray wooded soil.

Table 28. Carbon:nitrogen ratios in various horizons of virgin and cultivated soils from all soil zones

Location	Virgin or cultivated	Horizons Surface	Subsurface	Subsoil
		Black Soils		
Lloydminster	Virgin	12.4	10.9	
"	Cultivated	12.7	11.7	
Lloydminster	Virgin	12.3	10.8	9.1
"	Cultivated	11.8	10.1	10.2
Lacombe	Virgin	12.4	11.7	
"	Cultivated	13.1	13.3	
Vegreville	Virgin	13.3	12.0	
"	Cultivated	13.1	11.1	
"	"	13.0	11.2	
Pincher Creek	Virgin	13.8	11.2	
"	Cultivated	12.5	11.0	
Pincher Creek	Virgin	12.7	10.5	
"	Cultivated	12.0	8.3	
Parkland	Virgin	13.8	12.1	
"	Cultivated	12.8	11.5	
Parkland	Virgin	12.2	11.0	
"	Cultivated	11.8	9.5	
Yorkton	Virgin	11.3	11.2	
"	Cultivated	11.8	10.3	
Brandon	Virgin	12.8	11.7	
"	Cultivated	12.6	11.7	
P. La Prairie	Virgin	12.6	11.9	
"	Cultivated	11.9	11.7	
Selkirk	Virgin	12.6	11.3	
"	Cultivated	12.2	10.8	
Winkler	Virgin	12.1	12.5	
"	Cultivated	12.6	12.6	
		Dark Brown Soils		
Waskada	Virgin	12.2	11.4	
"	Cultivated	11.2	10.9	
Edgerton	Virgin	12.2	11.3	
"	Cultivated	11.2	9.7	
Edgerton	Virgin	13.1	12.1	
"	Cultivated	12.6	11.1	
Morrin	Virgin	11.9	10.2	
"	Cultivated	10.6	9.5	
Morrin	Virgin	11.0	9.6	9.4
"	Cultivated	10.2	8.9	9.0

Table 28 (continued)

Location	Virgin or cultivated	Horizons		
		Surface	Subsurface	Subsoil
Hand Hills	Virgin	13.0	12.6	
"	Cultivated	13.1	11.0	
Hand Hills	Virgin	13.4	9.8	11.7
"	Cultivated	12.5	10.3	11.7
Lethbridge	Virgin	12.4	11.6	
"	Cultivated	12.0	10.9	
Lethbridge	Virgin	11.7	9.9	
"	Cultivated	11.1	9.8	
Estevan	Virgin	12.2	10.3	
"	Cultivated	10.9		
Hanley	Virgin	11.4	10.0	
"	Cultivated	10.8	9.3	
	Brown Soils			
Gros Ventre	Virgin	14.0	11.2	
"	Cultivated	12.5	11.4	
Gros Ventre	Virgin	13.0	10.7	9.9
"	Cultivated	11.3	10.0	9.4
Cavendish	Virgin	12.6	11.0	
"	Cultivated	11.1	9.3	
Cavendish	Virgin	11.3	10.5	
"	Cultivated	10.6	9.0	
Brooks	Virgin	13.7	13.0	14.6
"	Cultivated	12.6	11.2	12.1
Brooks	Virgin	12.3	9.4	9.2
"	Cultivated	11.9	9.0	8.2
	Black Transition Soils			
High Prairie	Virgin	13.1	12.8	11.6
"	Cultivated	13.0	12.2	9.7
High Prairie	Virgin	13.3	12.2	13.0
"	Cultivated	11.8	12.4	11.3
Fairview	Virgin	11.3	9.7	9.3
"	Cultivated	11.1	8.7	9.0
Fairview	Virgin	11.8	10.7	9.8
"	Cultivated	10.7	9.4	9.6
Beaverlodge	Virgin	10.7	11.1	9.5
"	Cultivated	10.1	9.6	9.6
Grande Prairie	Virgin	11.3	9.1	9.9
"	Cultivated	10.1	8.6	8.5
Dauphin	Virgin	11.3	11.0	
"	Cultivated	10.8	10.9	

Table 28 (continued)

Location	Virgin or cultivated	Horizons Surface	 Subsurface	 Subsoil
		Gray Transition Soils		
Nampa	Virgin	12.0	8.0	7.4
"	Cultivated	11.3	7.4	8.7
Nampa	Virgin	12.0	8.0	7.4
"	Cultivated	9.6	8.2	6.5
Debolt	Virgin	9.5	8.4	9.0
"	Cultivated	9.4	9.0	9.7
Debolt	Virgin	9.5	8.4	9.0
"	Cultivated	11.8	8.2	8.2
		Gray Soils		
MacKay	Virgin	14.2	9.8	10.2
"	Cultivated	16.8	9.4	10.5
Gunn	Virgin	17.6	8.8	9.8
"	Cultivated	17.0	10.0	9.8
Goodfare	Virgin	14.6	8.4	10.1
"	Cultivated	11.9	9.5	9.9
Breton	Virgin	18.6	10.6	10.9
"	Cultivated	13.1	11.3	10.9
Breton	Virgin	18.6	10.6	10.9
"	Cultivated	13.8	10.7	9.4
Breton	Virgin	19.4	9.6	13.0
"	Cultivated	16.6	9.8	9.7
Cherhill	Virgin	15.8	10.9	11.9
"	Cultivated	14.3	9.2	10.6
Carrot Creek	Virgin	14.7	8.3	9.6
"	Cultivated	16.7	8.5	8.8
Edson	Virgin	15.7	9.0	14.0
"	Cultivated	12.5	8.6	15.8

In the black soils the carbon:nitrogen ratio in the surface horizon is about 12 and the cultivation has only slightly narrowed this figure. This comparison holds true for the subsurface horizon, although the carbon:nitrogen ratios on the whole are narrower than in the surface. The dark brown soils show similar comparisons in carbon:nitrogen ratios to the black soils. The brown soils, however, seem to have a slightly higher carbon:nitrogen ratio than either the black or dark brown and certainly the ratio has been reduced more under cultivation in the case of the brown soils than in either of the other two. The same holds true for the subsurface horizon.

Black transition soils show similar results for carbon:nitrogen ratios to the black soils. A slight narrowing has occurred due to cultivation and apparently extends in most cases in this zone to the subsoil.

The gray transition soils show some variation in regard to carbon:nitrogen ratios. A narrowing occurs in most cases in surface, subsurface and subsoil horizons. A notable exception is the second Debolt surface figures where the ratio for the cultivated is 11.8 or 2.3 above the virgin.

Probably the greatest narrowing of the carbon:nitrogen ratios occurs in the gray soils. Here the ratio runs up to almost 20 (at Breton) in virgin soil. The narrowing of the carbon:nitrogen ratio due to cultivation is more pronounced in these soils than in any of the other zones, in the surface horizon. In the other two horizons the narrowing

due to cultivation is not so great. It will be noticed, however, that there is a decided drop in the carbon:nitrogen ratio from the surface to the sub-surface horizons. The wide ratio in the surface virgin gray wooded soils can partially be accounted for by the fact that some of the organic carbon, so determined, is in the form of small pieces of wood and other slightly decomposed debris.

Total Phosphorus Results

The results of the total phosphorus determinations on cultivated and virgin soils are presented in Tables 29 to 36. Phosphorus was determined only on the surface and subsurface layers. Results for 50 locations are reported. One gray transition location is included in the gray soils table.

Black Soils

The total phosphorus results for 17 locations in the black soil zone are presented in Tables 29 and 30.

Considering Table 29, the surface layer in 11 locations has evidently lost phosphorus in percentages ranging from 0.003 to 0.025. In six other locations there have evidently been gains of from 0.001% to 0.023%. The average for the 17 figures amounts to a loss of 0.006% total phosphorus in the cultivated surface layer. In the second layer there are nine locations showing losses of phosphorus while eight show gains. However, on averaging these figures, they cancel themselves out so that in this layer neither a gain nor a loss

Table 29. Total phosphorus in virgin and cultivated black soils and loss or gain of phosphorus in cultivated soil

					Total P%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Vegreville	L.	Virgin	276[*]	0-8	.139		
	"	"	280[*]	"	.134	.137	
"	"	Cult. 30 yrs.	284[*]	0-6	.125		
"	"	"	288[*]	"	.116	.121	-.016
"	"	Cult. 10 yrs.	571	0-8	.110		
"	"	"	574	"	.114	.112	-.025
"	C.L.	Virgin	278[*]	8-26	.066		
"	"	"	282[*]	8-34	.070	.068	
"	"	Cult. 30 yrs.	286[*]	6-26	.054		
"	"	"	290[*]	6-27	.044	.049	-.019
"	"	Cult. 10 yrs.	572	8-14	.064		
"	"	"	575	"	.062	.063	-.005
Pincher Creek	Si.L.	Virgin	121[*]	0-7	.119		
	"	"	125[*]	"	.111	.115	
"	"	Cult. 27 yrs.	129[*]	"	.099		
"	"	"	133[*]	"	.110	.105	-.010
"	C.	Virgin	123[*]	7-22	.066		
"	"	"	127[*]	"	.064	.065	
"	"	Cult.	131[*]	"	.055		
"	"	"	135[*]	"	.058	.057	-.008
Pincher Creek	Si.L.	Virgin	775	0-8	.114		
	"	"	779	"	.121	.118	
"	"	Cult. 13 yrs.	781	"	.100		
"	"	"	783	"	.092	.096	-.022
"	C.	Virgin	776	8-18	.063		
"	"	"	780	"	.066	.065	
"	"	Cult.	782	"	.072		
"	"	"	784	"	.074	.073	+.008
Lloydminster	L.	Virgin	338	0-5	.064		
	"	"	342	"	.064	.064	
"	"	Cult. 30 yrs.	345	0-7	.086		
"	"	"	348	"	.087	.087	+.023
"	Si.L.	Virgin	339	5-11	.024		
"	"	"	343	"	.033	.029	
"	"	Cult.	346	7-11	.050		
"	"	"	349	"	.067	.059	+.030

[*] Figures obtained from Caldwell's thesis (1938) to give a comparison of older and newer fields.

Table 29 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Total P%		
						Av. of duplicates	Gain or loss
Lloyd-minster	L.	Virgin	469	0-8	.075		
"	"	"	471	"	.069	.072	
"	"	Cult. 30 yrs.	345	0-7	.086		
"	"	"	348	"	.087	.087	+.015
"	Si.L.	Virgin	470	8-11	.037		
"	"	"	472	"	.043	.040	
"	"	Cult.	346	7-11	.050		
"	"	"	349	"	.067	.059	+.019
Lloyd-minster	L.	Virgin	577	0-7	.084		
"	"	"	580	"	.082	.083	
"	"	Cult. 5 yrs.	583	"	.090		
"	"	"	586	"	.088	.089	+.006
"	Si.L.	Virgin	578	7-14	.053		
"	"	"	581	"	.051	.052	
"	"	Cult.	584	"	.045		
"	"	"	587	"	.043	.044	-.008
Lacombe	L.	Virgin	567	0-6	.077		
"	"	"	569	"	.082	.080	
"	"	(Cult. 26 yrs.	451	"	.084		
"	"	(Rot. 0	454	"	.083	.084	+.004
"	C.L.	Virgin	568	6-15	.072		
"	"	"	570	"	.070	.071	
"	"	Cult.	452	"	.068		
"	"	"	455	"	.069	.069	-.002
Parkland	L.	Virgin	137*	0-6	.100		
"	"	"	141*	"	.094	.097	
"	"	Cult. 27 yrs.	145*	"	.073		
"	"	"	149*	"	.076	.075	-.022
"	C.L.	Virgin	139*	6-20	.060		
"	"	"	143*	6-16	.068	.064	
"	"	Cult.	147*	6-14	.066		
"	"	"	151*	6-13	.074	.070	+.006
Parkland	L.	Virgin	785	0-6	.079		
"	"	"	788	"	.071	.075	
"	"	Cult. 10 yrs.	790	"	.082		
"	"	"	792	"	.084	.083	+.008
"	Si.L.	Virgin	786	6-15	.058		
"	"	"	789	"	.057	.058	
"	"	Cult.	791	"	.062		
"	"	"	793	"	.057	.060	+.002

* See footnote page 94.

					Total P%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Dauphin[*]	H.C.L.	Virgin	491	0-8	.153		
"	"	"	494	"	.153	.153	
"	"	Cult. 45 yrs.	497	"	.148		
"	"	"	499	"	.145	.147	-.006
"	C.L.	Virgin	492	8-16	.127		
"	"	"	495	"	.118	.123	
"	"	Cult.	498	"	.122		
"	"	"	500	"	.127	.125	+.002
Melfort	L.	Virgin	381	0-7	.112		
"	"	"	385	"	.114	.113	
"	"	Cult. 30 yrs.	389	"	.096		
"	"	"	392	"	.099	.098	-.015
"	Si.L.	Virgin	382	7-14	.084		
"	"	"	386	"	.082	.083	
"	"	Cult.	390	"	.085		
"	"	"	393	"	.087	.086	+.003
Selkirk	C.L.	Virgin	521	0-8	.121		
"	"	"	525	"	.118	.120	
"	"	Cult. 35 yrs.	529	"	.095		
"	"	"	531	"	.095	.095	-.025
"	C.	Virgin	522	8-18	.062		
"	"	"	526	"	.059	.061	
"	"	Cult.	530	8-20	.057		
"	"	"	532	"	.057	.057	-.004
P. La Prairie	Si.L.	Virgin	511	0-8	.083		
"	"	"	514	"	.087	.085	
"	"	Cult. 50 yrs.	517	"	.082		
"	"	"	519	"	.079	.081	-.004
"	"	Virgin	512	8-20	.066		
"	"	"	515	"	.066	.066	
"	"	Cult.	518	8-17	.069		
"	"	"	520	"	.067	.068	+.002
Yorkton	L.	Virgin	481	0-7	.085		
"	"	"	484	"	.081	.083	
"	"	Cult. 40 yrs.	487	"	.076		
"	"	"	489	"	.083	.080	-.003
"	Si.L.	Virgin	482	7-15	.068		
"	"	"	485	"	.067	.068	
"	"	Cult.	488	"	.059		
"	"	"	490	"	.055	.057	-.011

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[*] A black transition soil.

Table 29 (continued)

					Total P%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Brandon	F.S.L.	Virgin	501	0-7	.072		
"	"	"	504	"	.072	.072	
"	"	Cult. 50 yrs.	507	"	.061		
"	"	"	509	"	.061	.061	-.011
"	"	Virgin	502	7-17	.047		
"	"	"	505	"	.053	.050	
"	"	Cult.	508	"	.047		
"	"	"	510	"	.046	.047	-.003
Winkler	L.	Virgin	533	0-7	.063		
"	"	"	538	"	.066	.065	
"	"	Cult. 50 yrs.	543	"	.066		
"	"	"	545	"	.065	.066	+.001
"	"	Virgin	534	7-17	.073		
"	"	"	539	"	.077	.075	
"	"	Cult.	544	"	.063		
"	"	"	546	"	.063	.063	-.012

can be definitely shown.

Perhaps, as in the case of nitrogen and carbon, a clearer picture may be found from a study of the pounds per acre table (Table 30). In the surface 6-inch depth there are 11 losses, out of the 17 locations, ranging from 54 pounds to 450 pounds of phosphorus per acre. The six gains vary from 18 pounds to 519 pounds per acre. The average loss for the 17 figures is 105 pounds of phosphorus per acre. In the 6 to 12 inch layer, two figures that appear irregular are Vegreville (-756) and Lloydminster (+534). The average

Table 30. Loss or gain of total phosphorus in cultivated black soils on a pounds per acre basis

	Depth in inches			Total gain or loss
Location	0-6	6-12	12-18	
Vegreville	-288	-756	-342	-1386
"	-450	-210		-660
Pincher Creek	-180	-150		-330
" "	-396	-36	+144	-288
Lloydminster	+519	+534		+1053
"	+270	+177		+447
"	+108	-102		+6
Lacombe	+72	-36		+36
Parkland	-405	+108		-297
"	+144	+36		+180
Dauphin	-108	-12		-120
Melfort	-270	±000		-270
Selkirk	-450	-198	-72	-720
Portage La Prairie	-72	±000	+36	-36
Yorkton	-54	-174		-228
Brandon	-198	-78	-45	-321
Winkler	+18	-177	-180	-339
Av. loss or gain of P	-105	-63	-79	

for this second depth is a loss of only 63 pounds per acre. Only a few figures for the 12 to 18 inch depth are given (4 losses and 2 gains). The total loss or gain of phosphorus to the depth indicated is given in the columns at the extreme right of the table. They show quite a wide variation and thus make conclusions difficult and indefinite.

Dark Brown Soils

Phosphorus results for virgin and cultivated dark brown soils from 15 locations are presented in Tables 31 and 32.

Losses have evidently occurred at 10 out of the 15 locations in the surface cultivated layer (Table 31) ranging from 0.001% to 0.025% phosphorus. Only 3 gains were found while 2 apparently have neither lost nor gained in phosphorus. The average for the 15 locations is a loss of only 0.008% phosphorus. In the second layer, however, losses have apparently occurred at 7 places, while gains are shown at 8 places. All figures are quite low, with an average gain of 0.002% phosphorus in the cultivated subsurface layer.

The magnitude of the losses and gains is given in Table 32. The main point of interest is the variability and irregularity of the results. Losses in the first 6-inch depth range from 18 pounds to 450 pounds per acre, while gains vary from 33 pounds to 144 pounds per acre. The average is a loss in this depth of 143 pounds of phosphorus per acre. In the second 6-inch depth there are 8 losses and 7 gains with the average a gain of only 19 pounds. This last figure is negligible when one realizes that it amounts to only 0.001% of

Table 31. Total phosphorus in virgin and cultivated dark brown soils and loss or gain of phosphorus in

					Total P%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Edgerton	L.	Virgin	292*	0-8	.080		
"	"	"	296*	"	.087	.084	
"	"	Cult. 26 yrs.	300*	"	.081		
"	"	"	303*	"	.086	.084	.000
"	Si.L.	Virgin	294*	8-17	.058		
"	"	"	298*	8-21	.062	.060	
"	"	Cult.	301*	8-20	.070		
"	"	"	305*	"	.064	.067	+.007
Edgerton	L.	Virgin	693	0-7	.106		
"	"	"	697	"	.097	.102	
"	"	Cult. 12 yrs.	700	"	.078		
"	"	"	703	"	.076	.077	-.025
"	Si.L.	Virgin	694	7-12	.063		
"	"	"	698	"	.057	.060	
"	"	Cult.	701	"	.056		
"	"	"	704	"	.067	.062	+.002
Cutknife	L.	Virgin	361	0-7	.088		
"	"	"	364	"	.086	.087	
"	"	Cult. 31 yrs.	367	"	.071		
"	"	"	369	"	.069	.070	-.017
"	Si.L.	Virgin	362	7-22	.049		
"	"	"	365	7-28	.048	.049	
"	"	Cult.	368	7-26	.045		
"	"	"	370	7-22	.044	.045	-.004
Hand Hills	L.	Virgin	17*	0-8	.063		
	"	"	20*	"	.053	.058	
"	"	Cult. 20 yrs.	23*	0-6	.052		
"	"	"	26*	0-8	.065	.059	+.001
"	C.L.	Virgin	18*	8-14	.041		
"	"	"	21*	"	.042	.042	
"	"	Cult.	24*	6-12	.062		
"	"	"	27*	8-14	.054	.058	+.016

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* See footnote page 94.

Table 31 (continued)

					Total P%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Hand Hills	L.	Virgin	718	0-6	.076		
	"	"	722	"	.086	.081	
"	"	Cult. 9 yrs.	725	"	.065		
"	"	"	728	"	.060	.063	-.018
"	C.L.	Virgin	719	6-12	.036		
"	"	"	723	"	.036	.036	
"	"	Cult.	726	"	.041		
"	"	"	729	"	.040	.041	+.005
Regina S.	C.	Virgin	395	0-6	.080		
"	"	"	398	"	.074	.077	
"	"	Cult. 50 yrs.	401	"	.061		
"	"	"	403	"	.060	.061	-.016
"	"	Virgin	396	6-16	.063		
"	"	"	399	"	.063	.063	
"	"	Cult.	402	"	.055		
"	"	"	404	"	.055	.055	-.008
Regina E.	L.	Virgin	405	0-6	.086		
"	"	"	408	"	.081	.084	
"	"	Cult. 49 yrs.	411	"	.062		
"	"	"	413	"	.063	.063	-.021
"	C.L.	Virgin	406	6-18	.053		
"	"	"	409	"	.050	.052	
"	"	Cult.	412	6-16	.040		
"	"	"	413	"	.047	.044	-.008
Morrin	C.	Virgin	457	0-6	.078		
"	"	"	460	"	.076	.077	
"	"	Cult. 26 yrs.	463	"	.067		
"	"	"	466	"	.069	.068	-.009
"	"	Virgin	458	6-12	.064		
"	"	"	461	"	.063	.064	
"	"	Cult.	464	"	.061		
"	"	"	467	"	.060	.061	-.003
Morrin	C.	Virgin	706	0-6	.071		
"	"	"	709	"	.069	.070	
"	"	Cult. 13 yrs.	712	"	.068		
"	"	"	715	"	.071	.070	.000
"	"	Virgin	707	6-12	.061		
"	"	"	710	"	.067	.064	
"	"	Cult.	713	"	.061		
"	"	"	716	"	.060	.061	-.003

Table 31 (continued)

					Total P%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Scott	L.	Virgin	351	0-7	.071		
"	"	"	354	"	.073	.072	
"	"	(Cult. 12 yrs.	357	"	.078		
"	"	(Rot. D	359	"	.081	.080	+.008
"	Si.L.	Virgin	352	7-14	.048		
"	"	"	355	"	.044	.046	
"	"	Cult.	358	"	.064		
"	"	"	360	"	.061	.063	+.017
Estevan	L.	Virgin	557	0-6	.064		
"	"	"	560	"	.067	.066	
"	"	Cult. 35 yrs.	563	"	.053		
"	"	"	565	"	.056	.055	-.011
"	C.L.	Virgin	558	6-14	.039		
"	"	"	561	"	.040	.040	
"	"	Cult.	564	6-18	.043		
"	"	"	566	"	.042	.043	+.003
Lethbridge	Si.L.	Virgin	439	0-6	.060		
"	"	"	442	"	.057	.059	
"	"	(Cult. Rot. C	445	"	.054		
"	"	(Dry land	448	"	.052	.053	-.006
"	"	Virgin	440	6-18	.055		
"	"	"	443	"	.051	.053	
"	"	Cult.	446	6-12	.053		
"	"	"	449	"	.059	.056	+.003
Lethbridge	L.	Virgin	766	0-6	.062		
"	"	"	769	"	.060	.061	
"	"	Cult. 8 yrs.	771	"	.066		
"	"	"	773	"	.069	.068	+.007
"	Si.L.	Virgin	767	6-12	.055		
"	"	"	770	"	.057	.056	
"	"	Cult.	772	6-11	.060		
"	"	"	774	"	.070	.065	+.009
Hanley	L.	Virgin	473	0-7	.061		
"	"	"	475	"	.060	.061	
"	"	Cult. 30 yrs.	477	"	.059		
"	"	"	479	"	.060	.060	-.001
"	Si.L.	Virgin	474	7-15	.062		
"	"	"	476	"	.060	.061	
"	"	Cult.	478	"	.053		
"	"	"	480	"	.055	.054	-.007

Table 31 (continued)

					Total P%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Waskada	L.	Virgin	547	0-6	.079		
"	"	"	550	"	.078	.079	
"	"	Cult. 30 yrs.	553	"	.066		
"	"	"	555	"	.066	.066	-.013
"	Si.L.	Virgin	548	6-13	.060		
"	"	"	551	"	.063	.062	
"	"	Cult.	554	6-12	.061		
"	"	"	556	"	.059	.060	-.002

phosphorus. It is thus within the experimental error. At the extreme right of the table the total loss or gain to the depth indicated is given for each location. Wide variations are again self-evident.

Table 32. Loss or gain of total phosphorus in cultivated dark brown soils on a pounds per acre basis

	Depth in inches			Total loss or gain
Location	0-6	6-12	12-18	
Edgerton	0	+84	+126	+210
"	-450	-45		-495
Cutknife	-306	-111	-72	-489
Hand Hills	+33	+209		+242
" "	-324	+90		-234
Regina S.	-288	-144		-432
Regina E.	-378	-144		-522
Morrin	-162	-54		-216
"	±0	-54		-54
Scott	+144	+279		+423
Estevan	-198	+54		-144
Lethbridge	-108	+54		-54
"	+126	+162		+288
Hanley	-18	-108		-126
Waskada	-234	-36		-270
Av. loss or gain of P	-143	+16		

Brown Soils

The phosphorus results for eight cultivated and virgin brown soils are reported in Tables 33 and 34.

Losses were found at 5 out of 8 locations in the surface horizon, ranging from 0.007% to 0.020%. The 3 gains shown were at Brooks, and Cavendish (2 locations) with figures of 0.008%, 0.002% and 0.005% phosphorus respectively. The

Table 33. Total phosphorus in virgin and cultivated brown soils and loss or gain of phosphorus in cultivated soil

					Total P%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Swift		Virgin	415	0-6	.093		
Current		"	419	"	.086	.090	
"		Cult. 32 yrs.	423	"	.067		
"		"	426	"	.075	.071	-.019
"		Virgin	416	6-15	.055		
"		"	420	"	.044	.050	
"		Cult.	424	6-16	.049		
"		"	427	6-15	.054	.052	+.002
Gros	L.	Virgin	73[*]	0-6	.082		
Ventre	"	"	77[*]	"	.091	.087	
"	"	Cult. 20 yrs.	81[*]	"	.073		
"	"	"	85[*]	"	.070	.072	-.015
"	C.L.	Virgin	75[*]	6-20	.072		
"	"	"	79[*]	"	.072	.072	
"	"	Cult.	83[*]	"	.070		
"	"	"	87[*]	6-24	.073	.072	±.000
Gros	L.	Virgin	753	0-6	.074		
Ventre	"	"	757	"	.069	.072	
"	"	Cult. 9 yrs.	760	"	.055		
"	"	"	763	"	.053	.054	-.018
"	C.L.	Virgin	754	6-12	.051		
"	"	"	758	"	.044	.048	
"	"	Cult.	761	"	.046		
"	"	"	764	"	.045	.046	-.002
Cabri		Virgin	429	0-7	.064		
"		"	432	"	.062	.063	
"		Cult.	435	"	.056		
"		"	437	"	.056	.056	-.007
"		Virgin	430	7-21	.058		
"		"	433	"	.057	.058	
"		Cult.	436	7-22	.054		
"		"	438	"	.055	.055	-.003

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[*] Figures obtained from Caldwell's thesis (1938) to give a comparison of older and newer fields.

Table 33 (continued)

					Total P%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
Brooks	F.S.L.	Virgin	1[*]	0-9	.053		
"	"	"	5[*]	"	.064	.059	
"	"	(Cult. 12 yrs.	9[*]	"	.036		
"	"	(Irrigated	13[*]	"	.041	.039	-.020
"	"	Virgin	2[*]	9-16	.044		
"	"	"	6[*]	"	.042	.043	
"	"	Cult.	10[*]	"	.045		
"	"	"	14[*]	"	.039	.042	-.001
Brooks	L.	Virgin	731	0-6	.075		
"	"	"	735	"	.074	.075	
"	"	(Cult. 3 yrs.	738	"	.082		
"	"	(Irrigated	741	"	.083	.083	+.008
"	Si.L.	Virgin	732	6-12	.066		
"	"	"	736	"	.061	.064	
"	"	Cult.	739	"	.081		
"	"	"	742	"	.079	.080	+.016
Cavendish	F.S.L.	Virgin	41[*]	0-5	.056		
"	"	"	45[*]	"	.049	.053	
"	"	Cult. 23 yrs.	49[*]	"	.052		
"	"	"	53[*]	"	.057	.055	+.002
"	"	Virgin	43[*]	5-12	.055		
"	"	"	47[*]	"	.057	.056	
"	"	Cult.	51[*]	"	.058		
"	"	"	55[*]	"	.058	.058	+.002
Cavendish	L.	Virgin	744	0-6	.056		
"	"	"	747	"	.056	.056	
"	"	Cult. 11 yrs.	749	"	.057		
"	"	"	751	"	.064	.061	+.005
"	"	Virgin	745	6-14	.046		
"	"	"	748	"	.046	.046	
"	"	Cult.	750	"	.055		
"	"	"	752	"	.060	.058	+.012

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[*] See footnote page 105.

average loss for this horizon is 0.008% of phosphorus. It will be noted that samples from Brooks in both cases were obtained from irrigated land. In the second or subsurface layer losses have occurred at only 3 out of the 8 locations, gains at 4, and one location reveals neither a gain or loss. Differences are of a low order in all cases, the highest being +0.016% phosphorus for Brooks (6 to 12 inches).

Table 34. Loss or gain of total phosphorus in cultivated brown soils on a pounds per acre basis

	Depth in inches			Total loss or gain
Location	0-6	6-12	12-18	
Swift Current	-342	+36		-306
Gros Ventre	-270	-9	-9	-288
" "	-324	-36		-360
Cabri	-126	-66	-54	-246
Brooks	-360	-189	-18	-567
"	+144	+308		+452
Cavendish	+36	+36		+72
"	+90	+216		+306
Av. loss or gain of P	-144	+37		

From an examination of Table 34 the only figures of importance are those for the surface 6 inches. It will be noticed that the 5 locations showing losses have a range of 126 pounds to 342 pounds of phosphorus lost per acre, while the 3 gains only range from 36 pounds to 144 pounds. This gives an average loss of 144 pounds of phosphorus in the first 6-inch depth of the brown soils. The figures for the

second 6-inch depth are quite irregular and variable. The total loss or gain of phosphorus to the depth indicated is given in the extreme right hand column of Table 34. An average figure for these is of little value, since the indicated depths are not comparable.

Gray Soils

Total phosphorus results for virgin and cultivated gray transition (one location) and gray soils are contained in Tables 35 and 36.

Losses have evidently occurred in 7 out of 10 surface horizons in this soil zone, ranging from 0.003% to 0.024% phosphorus (Table 35). Only 3 gains were found. The average is a loss for this layer of only 0.006% of phosphorus. The gains or losses for the subsurface or second layer are extremely small, the largest being at Edson (-0.014% phosphorus) so that their significance is doubtful.

A glance at Table 36 reveals the fact that the average loss for the surface six inches has evidently been 101 pounds of phosphorus for the gray soils (one gray transition). It should also be noted that in the subsurface layer there have been 8 small losses while there have been only 2 gains. As in previous tables, the total loss or gain for the depths indicated is given in the extreme right hand column. The greatest total is a loss of 714 pounds of phosphorus which occurred at Edson. Only 3 locations show total gains, namely, Tweedsmuir, Cherhill and Carrot Creek. The

Table 35. Total phosphorus in virgin and cultivated gray transition and gray wooded soils and loss or gain of phosphorus in cultivated soil

					Total P%		
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches		Av. of duplicates	Gain or loss
MacKay	Si.L.	Virgin	591	0-7	.189		
"	"	"	594	"	.151	.170	
"	"	Cult. 14 yrs.	597	"	.180		
"	"	"	600	"	.151	.166	-.004
"	C.	Virgin	592	7-14	.070		
"	"	"	595	"	.084	.077	
"	"	Cult.	598	"	.082		
"	"	"	601	"	.070	.076	-.001
Gunn	L.	Virgin	633	0-7	.095		
"	"	"	636	"	.096	.096	
"	"	Cult.	639	"	.089		
"	"	"	642	"	.086	.088	-.008
"	C.L.	Virgin	634	7-14	.055		
"	"	"	637	"	.056	.056	
"	"	Cult.	640	"	.050		
"	"	"	643	"	.052	.051	-.005
Grosmont		Virgin	327	0-8	.076		
"		"	332	"	.075	.076	
"		Cult.	334	"	.075		
"		"	336	"	.069	.072	-.004
"		Virgin	328	8-20	.047		
"		"	333	"	.044	.046	
"		Cult.	335	"	.044		
"		"	337	"	.049	.047	+.001
Breton	Si.L.	Virgin	661	0-7	.075		
"	"	"	664	"	.074	.075	
"	"	Cult. E-1	667	"	.061		
"	"	"	670	"	.060	.061	-.014
"	C.	Virgin	662	7-14	.040		
"	"	"	665	"	.040	.040	
"	"	Cult.	668	"	.041		
"	"	"	671	"	.039	.040	±.000

Table 35 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Total P%		
						Av. of duplicates	Gain or loss
Breton	Si.L.	Virgin	661	0-7	.075		
"	"	"	664	"	.074	.075	
"	"	Cult. E-3	673	"	.068		
"	"	"	676	"	.065	.067	-.009
"	C.	Virgin	662	7-14	.040		
"	"	"	665	"	.040	.040	
"	"	Cult.	674	"	.039		
"	"	"	677	"	.039	.039	-.001
Breton	Si.L.	Virgin	681	0-7	.059		
"	"	"	684	"	.063	.061	
"	"	Cult. 15 yrs.	687	"	.058		
"	"	"	690	"	.058	.058	-.003
"	C.	Virgin	682	7-14	.049		
"	"	"	685	"	.047	.048	
"	"	Cult.	688	"	.043		
"	"	"	691	"	.044	.044	-.004
Carrot Creek	Si.L.	Virgin	605	0-7	.069		
"	"	"	608	"	.067	.068	
"	"	Cult. 5 yrs.	611	"	.069		
"	"	"	614	"	.069	.069	+.001
"	C.	Virgin	606	7-14	.042		
"	"	"	609	"	.043	.043	
"	"	Cult.	612	"	.042		
"	"	"	615	"	.041	.042	-.001
Edson	Si.L.	Virgin	619	0-7	.065		
"	"	"	622	"	.065	.065	
"	"	Cult. 25 yrs.	625	"	.042		
"	"	"	628	"	.039	.041	-.024
"	C.	Virgin	620	7-14	.049		
"	"	"	623	"	.046	.048	
"	"	Cult.	626	"	.035		
"	"	"	629	"	.033	.034	-.014
Tweedsmuir	F.S.L.	Virgin	371	0-7	.049		
"	"	"	374	"	.049	.049	
"	"	Cult.	377	"	.051		
"	"	"	379	"	.052	.052	+.003
"	S.L.	Virgin	372	7-36	.039		
"	"	"	375	"	.039	.039	
"	"	Cult.	378	"	.045		
"	"	"	380	"	.041	.043	+.004

Table 35 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Total P%		
						Av. of duplicates	Gain or loss
Cherhill	L.	Virgin	647	0-7	.044		
"	"	"	650	"	.046	.045	
"	"	Cult. 11 yrs.	653	"	.051		
"	"	"	656	"	.051	.051	+.006
"	C.	Virgin	648	7-14	.030		
"	"	"	651	"	.029	.030	
"	"	Cult.	654	"	.033		
"	"	"	657	"	.033	.033	+.003

Carrot Creek figure is somewhat irregular, having a gain in the first 6-inch depth and a loss in the second depth. For the most part, all the figures in this table represent rather small losses or gains and in many cases they are within the error in sampling or even the analytical error.

Table 36. Loss or gain of total phosphorus in cultivated gray transition and gray wooded soils on a pounds per acre basis

	Depth in inches			Total
Location	0-6	6-12	12-18	loss or gain
MacKay	-72	-27		-99
Gunn	-144	-99		-243
Grosmont	-72	-12		-84
Breton	-252	-42		-294
"	-162	-42		-204
"	-54	-69		-123
Carrot Creek	+18	-12		+6
Edson	-432	-282		-714
Tweedsmuir	+54	+69	+72	+195
Cherhill	+108	+63		+171
Av. loss or gain of P	-101	-45		

Effect of Length of Time of Cultivation on Total Phosphorus

As in the case of nitrogen and carbon, so also for total phosphorus, a comparison of the results for the older cultivated and more recently broken fields is given in Table 37. Only 11 locations in this comparison were available. It must also be noted that Brooks cultivated fields were both

Table 37. Loss or gain of total phosphorus (pounds per acre) in the first and second 6-inch depths showing a comparison of the effects of length of time cultivated

Location	Soil class	Yrs. cult.	Depth in inches		Total gain or loss	Yrs. cult.	Depth in inches		Total gain or loss
			0-6	6-12			0-6	6-12	
Vegreville	L.	30	-288	-756	-1044	10	-450	-210	-660
Pincher Creek	Si.L.	27	-180	-150	-330	13	-396	-36	-432
Lloydminster	L.	30	+395	+356	+751	5	+108	-102	+6
Parkland	L.	27	-405	+108	-297	10	+144	+36	+180
Edgerton	L.	26	0	+84	+84	12	-450	-45	-495
Hand Hills	L.	20	+33	+209	+242	9	-324	+90	-234
Morrin	C.	26	-162	-54	-216	13	0	-54	-54
Lethbridge	Si.L.	27*	-108	+54	-54	8**	+126	+162	+288
Gros Ventre	L.	20	-270	-9	-279	9	-324	-36	-360
Brooks	F.S.L.	12	-360	-189	-549	3**	+144	+308	+452
Cavendish	F.S.L.	23	+36	+36	+72	11**	+90	+216	+306
Average		24	-119	-28	-147	9	-121	+30	-91

* Number of years not definitely known, approximately 25-30.

** Loam soils.

irrigated. The table is divided in half as in the previous tables, so that the left hand side gives the results for the older fields and the right hand side the recently broken fields. Total amounts gained or lost are given for the first foot in depth.

The results for phosphorus are somewhat more variable than in the case of nitrogen and carbon. Three locations, at least, show a progressive decline of phosphorus, namely, Vegreville, Morrin, and possibly Brooks. Three show that greater losses have occurred in the relatively new field than in the older fields, as in Pincher Creek, Edgerton, and Gros Ventre. The average figures show that in the first foot of the 11 locations the older fields have lost 147 pounds of phosphorus, while the newer fields have lost only 91 pounds of phosphorus. Due to the extreme variations, however, these averages probably do not mean very much. It is apparent that further studies along this line are necessary before definite conclusions can be established.

Easily Soluble Phosphorus Results

The term "easily soluble phosphorus" refers to that part of the phosphorus extracted with an acid solution at a pH of 3. Results are reported for 49 locations, a location referring to each set of samples. Thus in the case of Vegreville two cultivated fields were sampled, both near

Table 38. Easily soluble phosphorus in virgin and cultivated black soils and increase or decrease in easily soluble phosphorus in cultivated soil

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Easily soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs. per acre 0"-6"
Vegreville	L.	Virgin	276	0-8	25			
	"	"	280	"	33	29		
"	"	(Cult.	571	"	37			
"	"	(10 yrs.	574	"	41	39	+10	+18
Pincher Creek	Si.L.	Virgin	775	0-8	30			
	"	"	779	"	33	32		
"	"	(Cult.	781	"	40			
"	"	(13 yrs.	783	"	38	39	+7	+13
Lloyd minster	L.	Virgin	338	0-5	33			
	"	"	342	"	39	36		
"	"	(Cult.	345	0-7	38			
"	"	(30 yrs.	348	"	29	34	-2	-3.6
Lloydminster	L.	Virgin	577	0-7	24			
	"	"	580	"	23	24		
"	"	(Cult.	583	"	18			
"	"	(5 yrs.	586	"	15	17	-7	-13
Lacombe	L.	Virgin	567	0-6	30			
"	"	"	569	"	31	31		
"	"	(Cult.	451	"				
"	"	(26 yrs.	454	"	30	30	-1	-1.8
		(Rot. 0						
Parkland	L.	Virgin	785	0-6	32			
"	"	"	788	"	32	32		
"	"	(Cult.	790	"	39			
"	"	(10 yrs.	792	"	42	41	+9	+16
Dauphin	H.C.L.	Virgin	491	0-8	280			
"	"	"	494	"	300	290		
"	"	(Cult.	497	"	230			
"	"	(45 yrs.	499	"	250	240	-50	-90

Table 38 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Easily soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs. per acre 0"-6"
Melfort	L.	Virgin	381	0-7	35			
"	"	"	385	"	38	37		
"	"	(Cult.	389	"	37			
"	"	(30 yrs.	392	"	33	35	-2	-3.6
Selkirk	C.L.	Virgin	521	0-8	114			
"	"	"	525	"	110	112		
"	"	(Cult.	529	"	76			
"	"	(35 yrs.	531	"	84	80	-32	-58
P. La Prairie	Si.L.	Virgin	511	0-8	136			
	"	"	514	"	126	131		
"	"	(Cult.	517	"	122			
"	"	(50 yrs.	519	"	118	120	-11	-20
Yorkton	L.	Virgin	481	0-7	70			
"	"	"	484	"	74	72		
"	"	(Cult.	487	"	64			
"	"	(40 yrs.	489	"	68	66	-6	-11
Brandon	F.S.L.	Virgin	501	0-7	62			
"	"	"	504	"	60	61		
"	"	(Cult.	507	"	52			
"	"	(50 yrs.	509	"	52	52	-9	-16
Winkler	L.	Virgin	533	0-7	61			
"	"	"	538	"	63	62		
"	"	(Cult.	543	"	50			
"	"	(50 yrs.	545	"	48	49	-13	-23

enough together to permit use of the virgin sample in comparison for both. Each of these will be referred to, however, as a separate location since a comparison figure is given for each. In the case of others two nearby locations were sampled, as at Pincher Creek, and each is a separate set of samples and thus a location. Easily soluble phosphorus was determined on the surface samples only. An attempt was made in this way to find out whether the phosphorus may be more available in the virgin than in the cultivated or vice versa. The results are expressed in parts per million, the increase or decrease expressed in parts per million as well as pounds per acre. Increase or decrease is used in this case rather than loss or gain, since easily soluble phosphorus varies in the soil even from one day to the next.

Black Soils

The results for easily soluble phosphorus in black soils are presented in Table 38.

It is interesting to note that only 3 locations out of 13 show increases of easily soluble phosphorus in the cultivated soil; all the others show decreases of varying amounts from one p.p.m. to 50 p.p.m. The average decrease for all locations amounts to 7 p.p.m. The increase or decrease in pounds per acre is obtained by multiplying the parts per million by 1.8 (one acre 6 inches taken to equal 1,800,000 pounds of soil).

It is evident from this table that the amount of easily soluble phosphorus present in the soil at any one

Table 39. Easily soluble phosphorus in virgin and cultivated dark brown soils and increase or decrease in easily soluble phosphorus in cultivated soil

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Easily soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Edgerton	L.	Virgin	693	0-7	27			
"	"	"	697	"	26	27		
"	"	(Cult.	700	"	28			
"	"	(12 yrs.	703	"	28	28	+1	+1.8
Cutknife	L.	Virgin	361	0-7	15			
"	"	"	364	"	16	16		
"	"	(Cult.	367	"	15			
"	"	(31 yrs.	369	"	16	16	±0	
Hand Hills	L.	Virgin	718	0-6	21			
	"	"	722	"	23	22		
"	"	(Cult.	725	"	19			
"	"	(9 yrs.	728	"	18	19	-3	-5.4
Regina S.	C.	Virgin	395	0-6	168			
"	"	"	398	"	168	168		
"	"	(Cult.	401	"	144			
"	"	(50 yrs.	403	"	144	144	-24	-43
Regina E.	L.	Virgin	405	0-6	16			
"	"	"	408	"	17	17		
"	"	(Cult.	411	"	16			
"	"	(49 yrs.	413	"	15	16	-1	-1.8
Morrin	C.	Virgin	457	0-6	64			
"	"	"	460	"	68	66		
"	"	(Cult.	463	"	88			
"	"	(26 yrs.	466	"	90	89	+23	+41
Morrin	C.	Virgin	706	0-6	103			
"	"	"	709	"	105	104		
"	"	(Cult.	712	"	135			
"	"	(13 yrs.	715	"	133	134	+30	+54

Table 39 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Easily soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Scott	L.	Virgin	351	0-7	17			
"	"	"	354	"	20	19		
"	"	(Cult.	357	"	22			
"	"	(12 yrs.	359	"	20	21	+2	+3.6
		(Rot. D						
Estevan	L.	Virgin	557	0-6	34			
"	"	"	560	"	28	31		
"	"	(Cult.	563	"	24			
"	"	(35 yrs.	565	"	24	24	-7	-13
Lethbridge	Si.L.	Virgin	439	0-6	55			
	"	"	442	"	62	59		
"	"	(Cult.	445	"	72			
"	"	(Rot. C	448	"	71	72	+13	+23
		(Dry land						
Lethbridge	L.	Virgin	766	0-6	99			
	"	"	769	"	91	95		
"	"	(Cult.	771	"	99			
"	"	(8 yrs.	773	"	103	101	+6	+11
Hanley	L.	Virgin	473	0-7	52			
"	"	"	475	"	56	54		
"	"	(Cult.	477	"	76			
"	"	(30 yrs.	479	"	78	77	+23	+41
Waskada	L.	Virgin	547	0-6	64			
"	"	"	550	"	66	65		
"	"	(Cult.	553	"	49			
"	"	(30 yrs.	555	"	51	50	-15	-27

time is quite small. It must also be realized that this amount varies from day to day. However, both virgin and cultivated samples were obtained at the same time with the exception of the Vegreville virgin and the second pair of cultivated samples (Nos. 571 and 574). The results for both fields at Vegreville nevertheless are quite similar.

Dark Brown Soils

The easily soluble results for the virgin and cultivated dark brown soils are contained in Table 39.

A study of this table reveals the fact that out of 13 locations 7 show increases of easily soluble phosphorus in amounts ranging from 1 p.p.m. to 30 p.p.m. One shows neither an increase nor a decrease, while 5 show decreases. The average for all is an increase of only 4 p.p.m. in the cultivated soil. While the actual increase or decrease in amounts of easily soluble phosphorus probably means very little, the number of pluses to minuses is more likely to give an indication of the effect of cultivation. Very little may be said regarding the number of pounds per acre increase or decrease except that the greatest figure is for Morrin with an increase of 54 pounds in the cultivated soil.

Brown Soils

The results for easily soluble phosphorus in virgin and cultivated fields are given in Table 40. Only 8 locations were sampled in this soil zone.

The results for this zone appear to be somewhat irregular, increases having occurred in three instances and

Table 40. Easily soluble phosphorus in virgin and cultivated brown soils and increase or decrease in easily soluble phosphorus in cultivated soil

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Easily soluble P p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Swift	L.	Virgin	415	0-6	39			
Current	"	"	419	"	40	40		
"	"	(Cult.	423	"	52			
"	"	(32 yrs.	426	"	50	51	+11	+20
Gros	L.	Virgin	753	0-6	48			
Ventre	"	"	757	"	49	49		
"	"	(Cult.	760	"	54			
"	"	(9 yrs.	763	"	55	55	+6	+11
Cabri	C.	Virgin	429	0-7	192			
"	"	"	432	"	200	196		
"	"	Cult.	435	"	160			
"	"	"	437	"	152	156	-40	-72
Brooks	L.	Virgin	731	0-6	71			
"	"	"	735	"	71	71		
"	"	(Cult.	738	"	61			
"	"	(3 yrs. (Irrigated	741	"	61	61	-10	-18
Caven-	L.	Virgin	744	0-6	101			
dish	"	"	747	"	101	101		
"	"	(Cult.	749	"	108			
"	"	(11 yrs.	751	"	112	110	+9	+16

Table 41. Easily soluble phosphorus in virgin and cultivated gray transition and gray wooded soils and increase or decrease in easily soluble phosphorus in cultivated soil

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Easily soluble P p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
MacKay	Si.L.	Virgin	591	0-7	145			
"	"	"	594	"	145	145		
"	"	(Cult.	597	"	210			
"	"	(14 yrs.	600	"	215	213	+68	+122
Gunn	L.	Virgin	633	0-7	128			
"	"	"	636	"	126	127		
"	"	Cult.	639	"	180			
"	"	"	642	"	168	174	+47	+84
Grosmont	L.-Si.L.	Virgin	327	0-8	74			
"	"	"	332	"	70	72		
"	"	Cult.	334	"	82			
"	"	"	336	"	82	82	+10	+18
Breton	Si.L.	Virgin	661	0-7	52			
"	"	"	664	"	48	50		
"	"	Cult.E-1	667	"	60			
"	"	"	670	"	58	59	+9	+16
Breton	Si.L.	Virgin	661	0-7	52			
"	"	"	664	"	48	50		
"	"	Cult.E-3	673	"	75			
"	"	"	676	"	67	71	+21	+38
Breton	Si.L.	Virgin	681	0-7	23			
"	"	"	684	"	21	22		
"	"	(Cult.	687	"	22			
"	"	(15 yrs.	690	"	19	21	-1	-1.8
Carrot Creek	Si.L.	Virgin	605	0-7	25			
	"	"	608	"	25	25		
"	"	(Cult	611	"	38			
"	"	(5 yrs.	614	"	34	36	+11	+20
Edson	Si.L.	Virgin	619	0-7	47			
"	"	"	622	"	47	47		
"	"	(Cult.	625	"	27			
"	"	(25 yrs.	628	"	28	28	-19	-34

Table 41 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Easily soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Tweeds-muir	F.S.L.	Virgin	371	0-7	49			
	"	"	374	"	49	49		
"	"	Cult.	377	"	50			
"	"	"	379	"	50	50	+1	+1.8
Cherhill	L.	Virgin	647	0-7	30			
"	"	"	650	"	32	31		
"	"	(Cult.	653	"	33			
"	"	(11 yrs.	656	"	34	34	+3	+5.4

decreases in two instances. The average is a decrease of only 5 p.p.m. in the cultivated soil. The greatest decrease occurred evidently at Cabri (a heavy clay soil). It will be noted that the cultivated samples from Brooks were obtained from irrigated fields.

Gray Soils

The easily soluble phosphorus results for virgin and cultivated gray soils are given in Table 41. One gray transition set of samples is included in this table along with 9 gray soil sets of samples.

Eight out of the 10 locations show increases of easily soluble phosphorus in the cultivated soil. These increases range from 1 p.p.m. up to 68 p.p.m. The two decreases are for Carrot Creek and Edson. The average for all 10 places amounts to an increase of 15 p.p.m. or 27 pounds per acre for the first 6-inch depth.

Water Soluble Phosphorus Results

Water soluble phosphorus, that portion of the phosphorus that can be extracted with ordinary distilled water, was determined on the surface samples of 72 cultivated fields and corresponding virgin soil. This was done to assist in arriving, with more certainty if possible, at the effects of cultivation and cropping on the soluble phosphorus in the soil. It has already been pointed out that there are many difficulties in trying to find out what happens to phosphorus in the soil under such conditions. Results are

Table 42. Water soluble phosphorus in virgin and cultivated black soils and increase or decrease in water soluble phosphorus in cultivated soil

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Water soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Edmonton	L.	Virgin	307	0-7	6.0			
"	"	"	312	"	6.2	6.1		
"	"	(Cult.	317	"	1.3			
"	"	(20 yrs.	321	"	2.2	1.8	-4.3	-7.7
		(Plot A-1						
Vegreville	L.	Virgin	276	0-8	4.1			
	"	"	280	"	3.8	4.0		
"	"	(Cult.	284	0-6	4.1			
"	"	(30 yrs.	288	"	4.1	4.1	+0.1	+0.18
"	"	Cult.)	571	0-8	1.6			
"	"	10 yrs.)	574	"	1.4	1.5	-2.5	-4.5
Pincher Creek	Si.L.	Virgin	121	0-7	4.0			
	"	"	125	"	3.2	3.6		
"	"	(Cult.	129	"	2.0			
"	"	(27 yrs.	133	"	2.0	2.0	-1.6	-2.9
Pincher Creek	Si.L.	Virgin	775	0-8	4.0			
	"	"	779	"	2.4	3.2		
"	"	(Cult.	781	"	0.9			
"	"	(13 yrs.	783	"	0.9	0.9	-2.3	-4.1
Namao	L.	Virgin	256	0-9	5.6			
"	"	"	261	"	6.6	6.1		
"	"	(Cult.	266	"	4.4			
"	"	(30 yrs.	271	0-8	5.2	4.8	-1.3	-2.3
Lacombe		Virgin	153	0-6	3.4			
"		"	158	"	3.0	3.2		
"		Cult.	163	"	2.5			
"		"	167	"	2.0	2.3	-0.9	-1.6
Lacombe		Virgin	567	0-6	2.6			
"		"	569	"	2.3	2.5		
"		Cult.	451	"	2.1			
"		"	454	"	2.5	2.3	-0 .2	-0.36

Table 42 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Water soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Lloydminster	L.	Virgin	338	0-5	6.2			
	"	"	342	"	5.8	6.0		
"	"	(Cult.	345	0-7	3.5			
"	"	(30 yrs.	348	"	3.2	3.4	-2.6	-4.7
Lloydminster	L.	Virgin	577	0-7	2.0			
	"	"	580	"	2.2	2.1		
"	"	(Cult.	583	"	0.9			
"	"	(5 yrs.	586	"	0.9	0.9	-1.2	-2.2
Parkland	L.	Virgin	137	0-6	1.7			
"	"	"	141	"	1.3	1.5		
"	"	(Cult.	145	"	0.9			
"	"	(27 yrs.	149	"	1.1	1.0	-0.5	-0.9
Parkland	L.	Virgin	785	0-6	1.4			
"	"	"	788	"	1.3	1.4		
"	"	(Cult.	790	"	1.2			
"	"	(10 yrs.	792	"	1.3	1.3	-0.1	-0.18
Dauphin	H.C.L.	Virgin	491	0-8	5.0			
"	"	"	494	"	5.5	5.3		
"	"	(Cult.	497	"	1.3			
"	"	(45 yrs.	499	"	1.2	1.3	-4.0	-7.2
Melfort	L.	Virgin	381	0-7	4.6			
"	"	"	385	"	4.8	4.7		
"	"	(Cult.	389	"	2.5			
"	"	(30 yrs.	392	"	2.3	2.4	-2.3	-4.1
Selkirk	C.L.	Virgin	521	0-8	4.9			
"	"	"	525	"	5.1	5.0		
"	"	(Cult.	529	"	1.4			
"	"	(35 yrs.	531	"	2.2	1.8	-3.2	-5.8

Table 42 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Water soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
P. La	Si.L.	Virgin	511	0-8	5.4			
Prairie	"	"	514	"	4.5	5.0		
"	"	(Cult. 50	517	"	1.7			
"	"	(years	519	"	1.8	1.8	-3.2	-5.8
Yorkton	L.	Virgin	481	0-7	3.7			
"	"	"	484	"	3.2	3.5		
"	"	(Cult.	487	"	1.7			
"	"	(40 yrs.	489	"	1.5	1.6	-1.9	-3.4
Brandon	F.S.L.	Virgin	501	0-7	5.2			
"	"	"	504	"	5.4	5.3		
"	"	(Cult.	507	"	1.8			
"	"	(50 yrs.	509	"	1.2	1.5	-3.8	-6.8
Waskada	L.	Virgin	547	0-6	3.0			
"	"	"	550	"	3.5	3.3		
"	"	(Cult.	553	"	1.7			
"	"	(30 yrs.	555	"	1.7	1.7	-1.6	-2.9
Winkler	L.	Virgin	533	0-7	2.4			
"	"	"	538	"	2.1	2.3		
"	"	(Cult.	543	"	1.8			
"	"	(50 yrs.	545	"	1.8	1.8	-0.5	-0.9

expressed in parts per million with a column at the extreme right of each table showing the increase or decrease in pounds per acre to the 6-inch depth.

Black Soils

The water soluble phosphorus results for 20 fields in the black soil zone are given in Table 42.

The interesting thing about this table is the fact that out of 20 locations only one shows an increase of water soluble phosphorus under cultivation, viz. Vegreville. While the quantities are all quite small, there seems to be an indication from the number of pluses to minuses that there is a decrease of this phosphorus in the cultivated black soils. It is natural for the amount of water soluble phosphorus in soils to be rather small, usually only a few parts per million. Average figures are of little value in this case.

Dark Brown Soils

Samples from 15 locations in the dark brown soil zone were analyzed for water soluble phosphorus, the results being presented in Table 43.

Here again only one location (Hanley) out of the 15 shows an increase in the amount of water soluble phosphorus in the cultivated soil. The figures are small in most cases but there still seems to be a tendency at least for a lesser amount of water soluble phosphorus to be present in the cultivated as compared with the virgin soil.

Table 43. Water soluble phosphorus in virgin and cultivated dark brown soils and increase or decrease in water soluble phosphorus in cultivated soil

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Water soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Edgerton	L.	Virgin	292	0-8	6.0			
"	"	"	296	"	5.6	5.8		
"	"	(Cult.	300	"	2.4			
"	"	(26 yrs.	303	"	2.2	2.3	-3.5	-6.3
Edgerton	L.	Virgin	693	0-7	3.0			
"	"	"	697	"	2.8	2.9		
"	"	(Cult.	700	"	1.6			
"	"	(12 yrs.	703	"	1.5	1.6	-1.3	-2.3
Hand Hills	L.	Virgin	17	0-8	4.2			
	"	"	20	"	4.1	4.2		
"	"	(Cult.	23	0-6	3.3			
"	"	(20 yrs.	26	0-8	4.0	3.7	-0.5	-0.9
Hand Hills	L.	Virgin	718	0-6	1.4			
	"	"	722	"	1.3	1.4		
"	"	(Cult.	725	"	1.3			
"	"	(9 yrs.	728	"	1.1	1.2	-0.2	-0.36
Lethbridge	Si.L.	Virgin	105	0-5	1.5			
	"	"	109	"	1.5	1.5		
"	"	(Cult. Rot.U	113	"	0.7			
"	"	(Irrig.	117	"	0.8	0.8	-0.7	-1.3
Lethbridge	Si.L.	Virgin	439	0-6	1.2			
	"	"	442	"	1.3	1.3		
"	"	(Cult.Rot.C	445	"	0.9			
"	"	(Dry land	448	"	0.7	0.8	-0.5	-0.9
Lethbridge	L.	Virgin	766	0-6	1.3			
	"	"	769	"	1.1	1.2		
"	"	(Cult.	771	"	1.0			
"	"	(8 yrs.	773	"	1.0	1.0	-0.2	-0.36

Table 43 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Water soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Cutknife	L.	Virgin	361	0-7	2.3			
"	"	"	364	"	2.4	2.4		
"	"	(Cult.	367	"	1.4			
"	"	(31 yrs.	369	"	1.4	1.4	-1.0	-1.8
Regina S.	C.	Virgin	395	0-6	2.3			
"	"	"	398	"	2.3	2.3		
"	"	(Cult.	401	"	1.0			
"	"	(50 yrs.	403	"	1.8	1.4	-0.9	-1.6
Regina E.	L.	Virgin	405	0-6	2.2			
"	"	"	408	"	2.6	2.4		
"	"	(Cult.	411	"	0.7			
"	"	(49 yrs.	413	"	0.8	0.8	-1.6	-2.9
Morrin	C.	Virgin	457	0-6	2.2			
"	"	"	460	"	2.2	2.2		
"	"	(Cult.	463	"	0.6			
"	"	(26 yrs.	466	"	0.8	.07	-1.5	-2.7
Morrin	C.	Virgin	706	0-6	1.3			
"	"	"	709	"	1.1	1.2		
"	"	(Cult.	712	"	1.1			
"	"	(13 yrs.	715	"	1.1	1.1	-0.1	-0.18
Hanley	L.	Virgin	473	0-7	0.8			
"	"	"	475	"	1.0	0.9		
"	"	(Cult.	477	"	1.1			
"	"	(30 yrs.	479	"	1.1	1.1	+0.2	-0.36
Scott	L.	Virgin	351	0-7	2.5			
"	"	"	354	"	2.4	2.5		
"	"	(Cult.	357	"	2.0			
"	"	(12 yrs. (Rot. D	359	"	1.6	1.8	-0.7	-1.3
Estevan	L.	Virgin	557	0-6	3.8			
"	"	"	560	"	3.9	3.9		
"	"	(Cult.	563	"	1.9			
"	"	(35 yrs.	565	"	1.8	1.9	-2.0	-3.6

Table 44. Water soluble phosphorus in virgin and cultivated brown soils and increase or decrease in water soluble phosphorus in cultivated soil

					Water soluble P			
Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Brooks	F.S.L.	Virgin	1	0-9	4.8			
"	"	"	5	"	5.4	5.1		
"	"	(Cult.	9	"	1.3			
"	"	(12 yrs. (Irrig.	13	"	1.2	1.3	-3.8	-6.8
Brooks	L.	Virgin	731	0-6	5.1			
"	"	"	735	"	4.3	4.7		
"	"	(Cult.	738	"	2.1			
"	"	(3 yrs. (Irrig.	741	"	2.0	2.1	-2.6	-4.7
Acadia Valley	C.	Virgin	29	0-6	1.1			
"	"	"	32	"	0.9	1.0		
"	"	(Cult.	35	"	1.2			
"	"	(22 yrs.	38	"	1.3	1.3	+0.3	+0.54
Caven-dish	F.S.L.	Virgin	41	0-5	1.0			
"	"	"	45	"	0.8	0.9		
"	"	(Cult.	49	"	0.7			
"	"	(23 yrs.	53	"	0.6	0.7	-0.2	-0.36
Caven-dish	L.	Virgin	744	0-6	1.8			
"	"	"	747	"	1.6	1.7		
"	"	(Cult.	749	"	1.9			
"	"	(11 yrs.	751	"	2.1	2.0	+0.3	+0.54
Swift Current	L.	Virgin	57	0-6	4.4			
"	"	"	61	"	3.8	4.1		
"	"	(Cult.	65	"	2.7			
"	"	(20 yrs.	69	"	2.5	2.6	-1.5	-2.7
Swift Current		Virgin	415	0-6	5.5			
		"	419	"	5.2	5.4		
"		(Cult.	423	"	2.2			
"		(32 yrs.	426	"	1.9	2.1	-3.3	-5.9

Table 44 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Water soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Manyberries	L.	Virgin	89	0-6	0.8			
	"	"	93	"	1.0			
"	"	(Cult.	97	"	1.2			
"	"	(23 yrs.	101	"	1.3	1.3	+0.4	-0.72
Gros Ventre	L.	Virgin	73	0-6	2.7			
	"	"	77	"	2.8	2.8		
"	"	(Cult.	81	"	0.8			
"	"	(20 yrs.	85	"	0.9	0.9	-1.9	-3.4
Gros Ventre	L.	Virgin	753	0-6	1.3			
	"	"	757	"	1.2	1.3		
"	"	(Cult.	760	"	1.1			
"	"	(9 yrs.	763	"	1.1	1.1	-0.2	-0.36
Cabri	C.	Virgin	429	0-7	1.2			
"	"	"	432	"	1.7	1.5		
"	"	Cult.	435	"	0.7			
"	"	"	437	"	1.0	0.9	-0.6	-1.08

Brown Soils

The water soluble phosphorus results for virgin and cultivated brown soils from 11 locations are presented in Table 44.

Three out of the 11 locations show increases of water soluble phosphorus under cultivation in this zone. This is, however, still a predominant number of decreases. The quantities are still very small and while the amounts may not be very significant, the positive or negative sign in front may have a bearing on the question. The negative sign for the cultivated soil has been obtained fairly consistently throughout these water soluble results. It must be noted that Brooks samples were obtained from irrigated fields.

Gray Soils

The water soluble phosphorus results for virgin and cultivated gray soils from 14 locations, and gray transition from two locations, are presented in Table 45. Only 3 out of the 16 locations show increases of water soluble phosphorus in the cultivated soils; the other 13 show decreases. As before, the actual amounts of these decreases or increases is quite small but there still is a predominance of decreases in the cultivated fields.

Table 45. Water soluble phosphorus in virgin and cultivated gray soils and increase or decrease in water soluble phosphorus in cultivated soil

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Water soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Breton	Si.L.	Virgin	173	0-7	4.3			
"	"	"	178	"	5.0	4.7		
"	"	(Cult. C-1	181	"	1.0			
"	"	(Check	185	"	1.1	1.1	-3.6	-6.5
"	"	Cult. C-3)	189	"	0.6			
"	"	Complete)	193	"	0.9	0.8	-3.9	-7.0
Breton	Si.L.	Virgin	661	0-7	0.6			
"	"	"	664	"	0.8	0.7		
"	"	Cult.E-1	667	"	0.7			
"	"	"	670	"	0.4	0.6	-0.1	-0.18
"	"	Cult.E-3	673	"	0.6			
"	"	"	676	"	0.9	0.8	+0.1	+0.18
Breton	Si.L.	Virgin	681	0-7	1.1			
"	"	"	684	"	0.9	1.0		
"	"	(Cult.	687	"	0.5			
"	"	(15 yrs.	690	"	0.5	0.5	-0.5	-0.9
Fallis	Si.L.	Virgin	199	0-7	3.0			
"	"	"	204	"	3.9	3.5		
"	"	(Cult.	206	"	0.6			
"	"	(24 yrs.	210	"	0.8	0.7	-2.8	-5.0
MacKay	Si.L.	Virgin	216	0-7	1.7			
"	"	"	222	"	1.4	1.6		
"	"	(Cult. 5 yrs.	226	"	1.5			
"	"	(Fert.	229	"	2.1	1.8	+0.2	+0.36
"	"	Cult. 3 yrs.)	232	"	0.9			
"	"	No fert.)	234	"	0.9	0.9	-0.7	-1.3
MacKay		Virgin	591	0-7	2.9			
"		"	594	"	3.4	3.2		
"		Cult.	597	"	5.0			
"		"	600	"	4.6	4.8	+1.6	+2.3

Table 45 (continued)

Location	Soil class	Virgin or cultivated	Sample No.	Depth in inches	Water soluble P			
					p.p.m.	Av. of duplicates p.p.m.	Increase or decrease p.p.m.	Increase or decrease Lbs./acre 0"-6"
Colinton	Si.L.	Virgin	238	0-8	2.9			
"	"	"	243	"	2.4	2.7		
"	"	(Cult.	246	0-6	0.8			
"	"	(20 yrs.	251	"	0.9	0.9	-1.8	-3.2
Grosmont		Virgin	327	0-8	4.4			
"		"	332	"	4.0	4.2		
"		Cult.	334	"	1.9			
"		"	336	"	1.8	1.9	-2.3	-4.1
Tweedsmuir		Virgin	371	0-7	4.9			
"		"	374	"	4.6	4.8		
"		Cult.	377	"	3.6			
"		"	379	"	3.2	3.4	-1.4	-2.5
Carrot Creek	Si.L.	Virgin	605	0-7	0.6			
"	"	"	608	"	0.8	0.7		
"	"	Cult.	611	"	0.9			
"	"	"	614	"	0.5	0.7	±0.0	---
Edson	Si.L.	Virgin	619	0-7	0.7			
"	"	"	622	"	0.8	0.8		
"	"	Cult.	625	"	0.3			
"	"	"	628	"	0.4	0.4	-0.4	-0.7
Gunn	L.	Virgin	633	0-7	2.4			
"	"	"	636	"	2.1	2.3		
"	"	Cult.	639	"	2.5			
"	"	"	642	"	2.5	2.5	+0.2	+0.36
Cherhill	L.	Virgin	647	0-7	2.3			
"	"	"	650	"	2.1	2.2		
"	"	(Cult.	653	"	0.6			
"	"	(11 yrs.	656	"	0.4	0.5	-1.7	-3.1

Nitrification Results

Nitrification studies were carried on with 10 sets of samples representing 10 virgin and the same number of cultivated fields. At the end of 90 days incubation the tumblers were removed and leached free of nitrates. They were then brought to the optimum moisture and returned to the incubator. Thus an attempt was made to ascertain the relative nitrifying power of virgin and cultivated soils and also to see how each could recover after having the nitrates, etc., leached out. The data are presented in parts per million in Table 45, for the number of days incubated as shown.

However, in graphs 1 to 10 the results are more easily and clearly shown in graphic form. In most cases the virgin samples seem to have a greater nitrifying power than the cultivated samples. This may not be evident until after a period of 30 or even 60 days incubation. After leaching the nitrifying power of both virgin and cultivated samples is considerably reduced, but again the virgin samples in most cases seem to be slightly higher in nitrates than the cultivated ones. The great reduction in nitrifying power due to the leaching may be partially explained by the fact that considerable amounts of organic material were evidently washed out from the soil. Soil colloids were no doubt removed to a considerable extent. This would mean that much of the available food for the organisms responsible for nitrification had been removed as well as some of the nitrogen compounds that serve as starting material for nitrate production.

Table 46. Nitrate nitrogen (p.p.m.) in surface horizon of virgin and cultivated soils

Location	Virgin or cultivated	Sample No.	Days incubated *									
			0	15	30	60	90	15	30	45	75	105
Lloyd-minster	Virgin	338	6	17	91	167	250	18	25	32	34	58
	"	342	6	15	50	154	250	22	33	36	44	64
"	Cult. 30 yrs.	345	12	29	77	133	179	14	18	32	36	66
"	"	348	10	36	77	118	156	13	20	30	36	60
Scott	Virgin	351	14	53	77	111	128	11	12	21	29	43
"	"	354	13	67	91	111	139	11	14	24	30	49
"	(Cult. 12 yrs.	357	28	56	91	118	143	10	11	18	24	45
"	(Rot. D	359	22	44	71	111	132	9	12	20	26	47
Cutknife	Virgin	361	2	24	71	118	125	13	15	23	31	45
"	"	364	2	19	71	111	132	13	14	25	27	46
"	Cult. 31 yrs.	367	3	18	50	74	78	9	9	19	26	37
"	"	369	3	25	56	87	96	11	13	21	26	41
Melfort	Virgin	381	2	23	111	250	278	24	33	44	54	89
"	"	385	3	29	125	267	333	29	34	51	56	94
"	Cult. 30 yrs.	389	11	29	62	143	179	18	27	34	45	72
"	"	392	13	36	77	143	114	18	19	30	45	62
Regina E.	Virgin	405	5	53	87	121	148	9	13	16	33	36
"	"	408	6	59	100	129	167	9	13	18	40	45
"	Cult. 49 yrs.	411	14	42	56	83	98	8	8	12	23	24
"	"	413	15	40	56	78	93	5	7	13	24	25
Swift Current	Virgin	415	trace	56	133	200	278	16	15	23	30	49
	"	419	trace	67	143	200	250	26	13	28	43	58
"	Cult. 31 yrs.	423	45	95	118	160	196	6	12	18	27	29
"	"	426	42	91	125	160	200	7	12	19	26	35

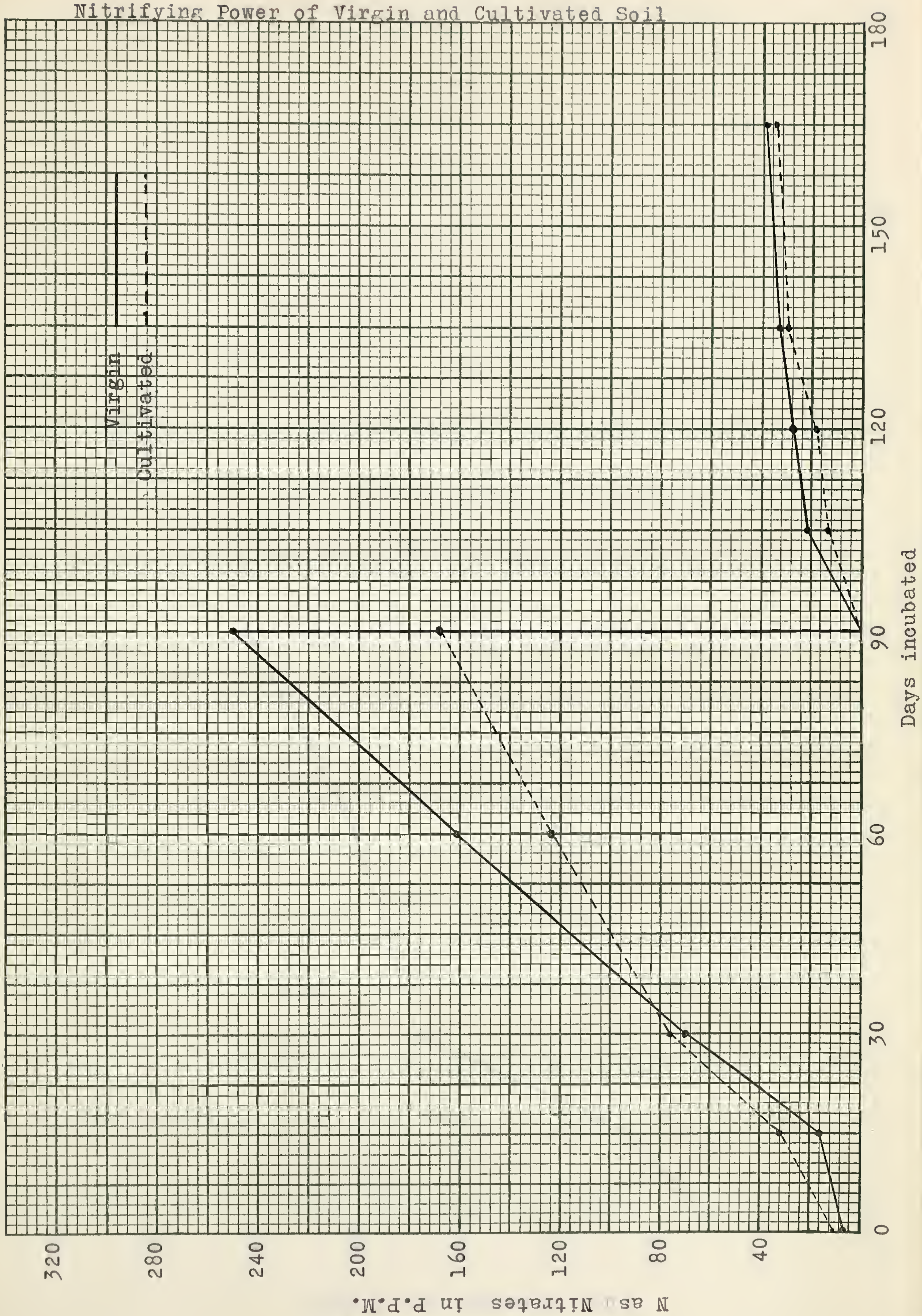
Table 46 (continued)

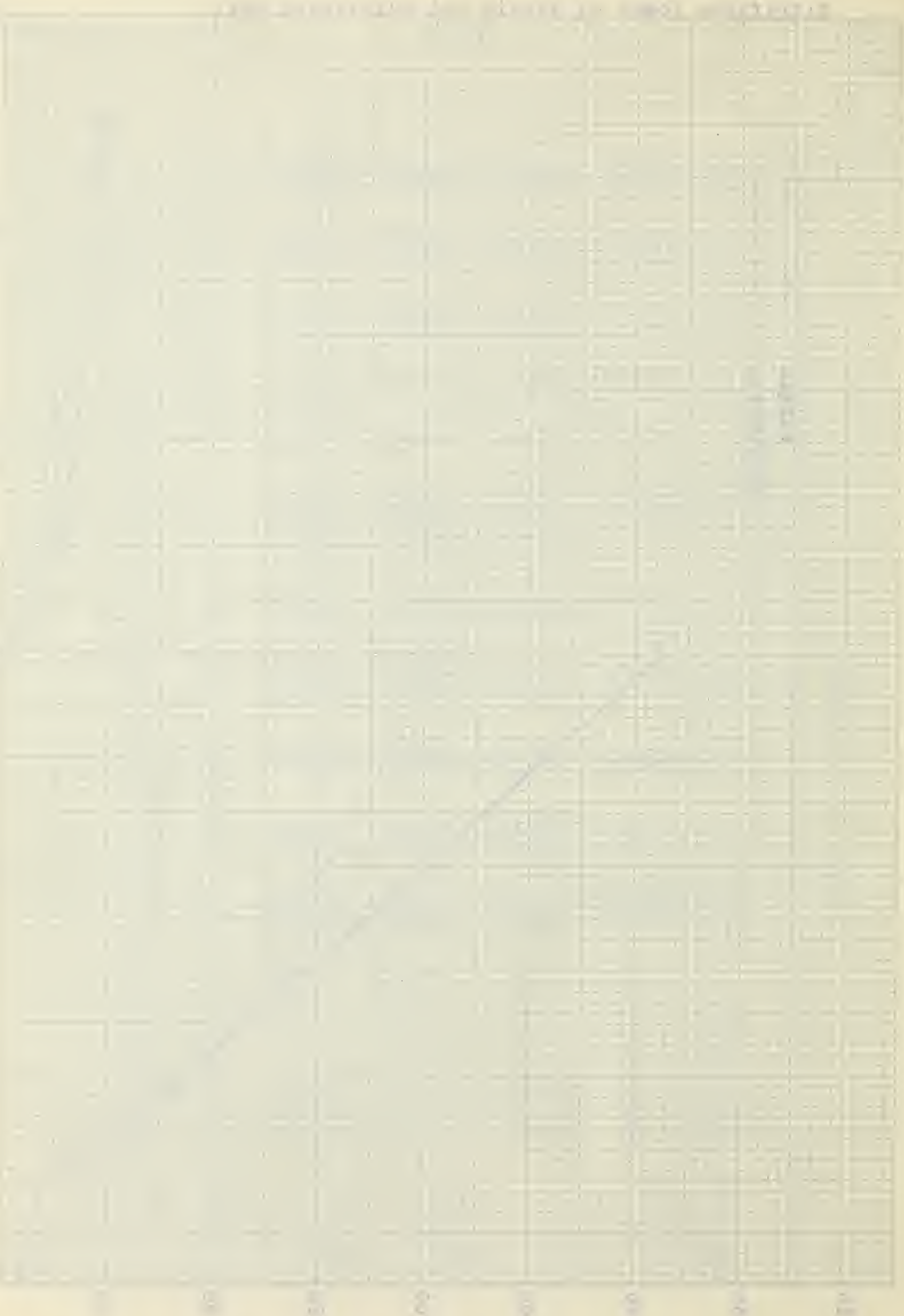
Location	Virgin or cultivated	Sample No.	Days incubated[*]									
			0	15	30	60	90	15	30	45	75	105
Cabri	Virgin	429	5	24	28	36	48	6	11	9	14	19
"	"	432	6	23	31	42	50	7	10	8	11	24
"	Cult. 27 yrs.	435	10	28	33	52	63	8	9	6	15	18
"	"	437	8	24	31	50	59	6	7	8	16	trace
Morrin	Virgin	457	trace	67	143	182	222	12	21	28	48	54
"	"	460	trace	83	133	160	200	12	21	32	44	41
"	Cult. 26 yrs.	463	36	100	111	129	160	10	19	43	44	33
"	"	466	29	83	105	125	167	8	20	39	26	48
Hanley	Virgin	473	45	56	105	114	138	5	trace	12	17	20
"	"	475	31	33	80	95	108	6	6	14	17	22
"	Cult. 30 yrs.	477	50	71	95	111	138	8	7	15	29	22
"	"	479	12	59	77	95	114	10	17	26	48	37
Yorkton	Virgin	481	56	83	143	167	222	11	15	29	46	45
"	"	484	62	100	210	235	270	14	21	28	46	47
"	Cult. 40 yrs.	487	11	67	91	118	143	12	21	33	43	36
"	"	489	62	71	100	125	160	13	19	24	37	40

[*] At the end of 90 days incubation the samples were all leached until only a trace of N as NO_3 remained; the days were then counted from date returned to incubator as 15, 30, 45, 75, 105, above.

LLOYDMINSTER - Black-L Graph I

Nitrifying Power of Virgin and Cultivated Soil

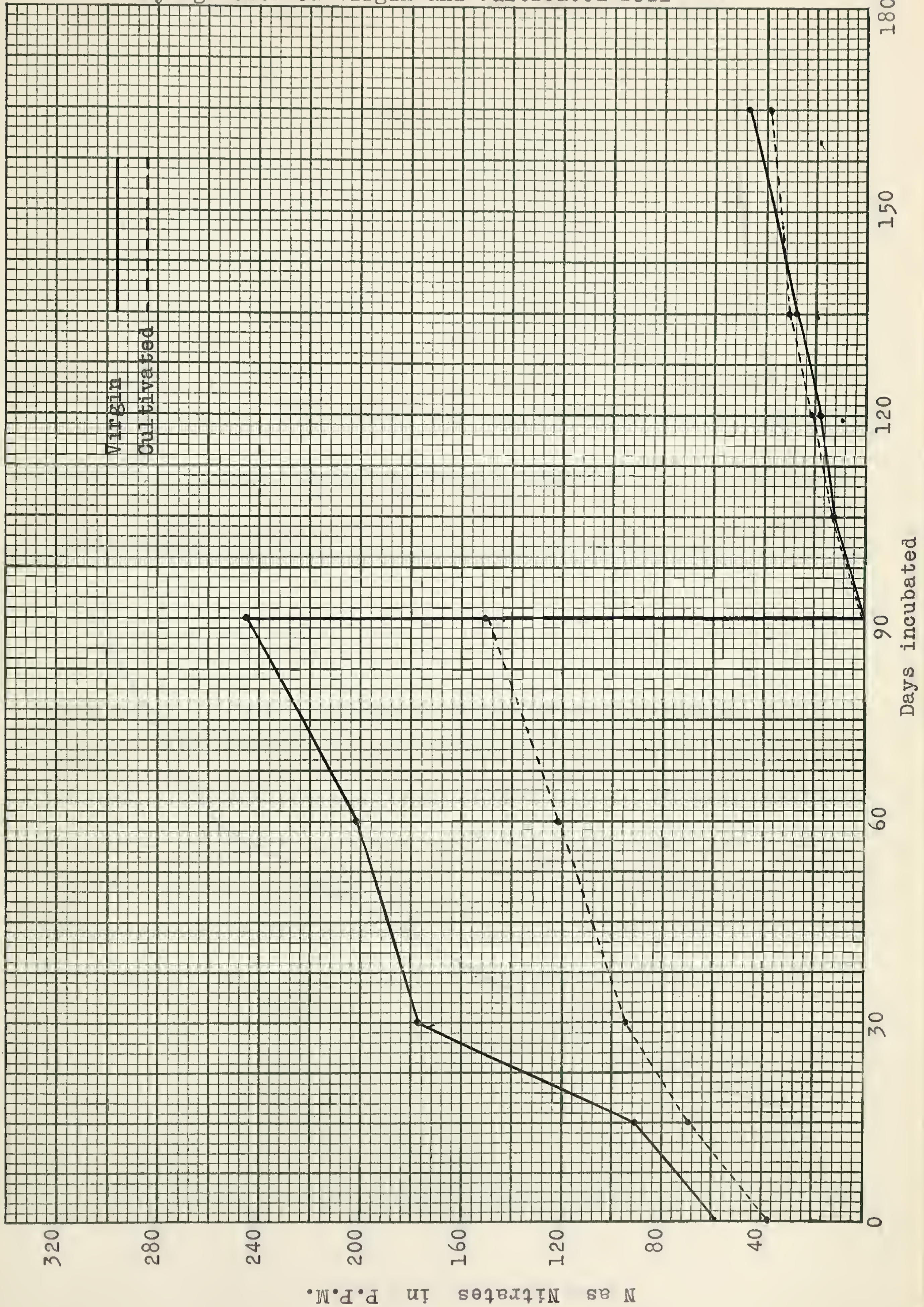




YORKTON - Black-L

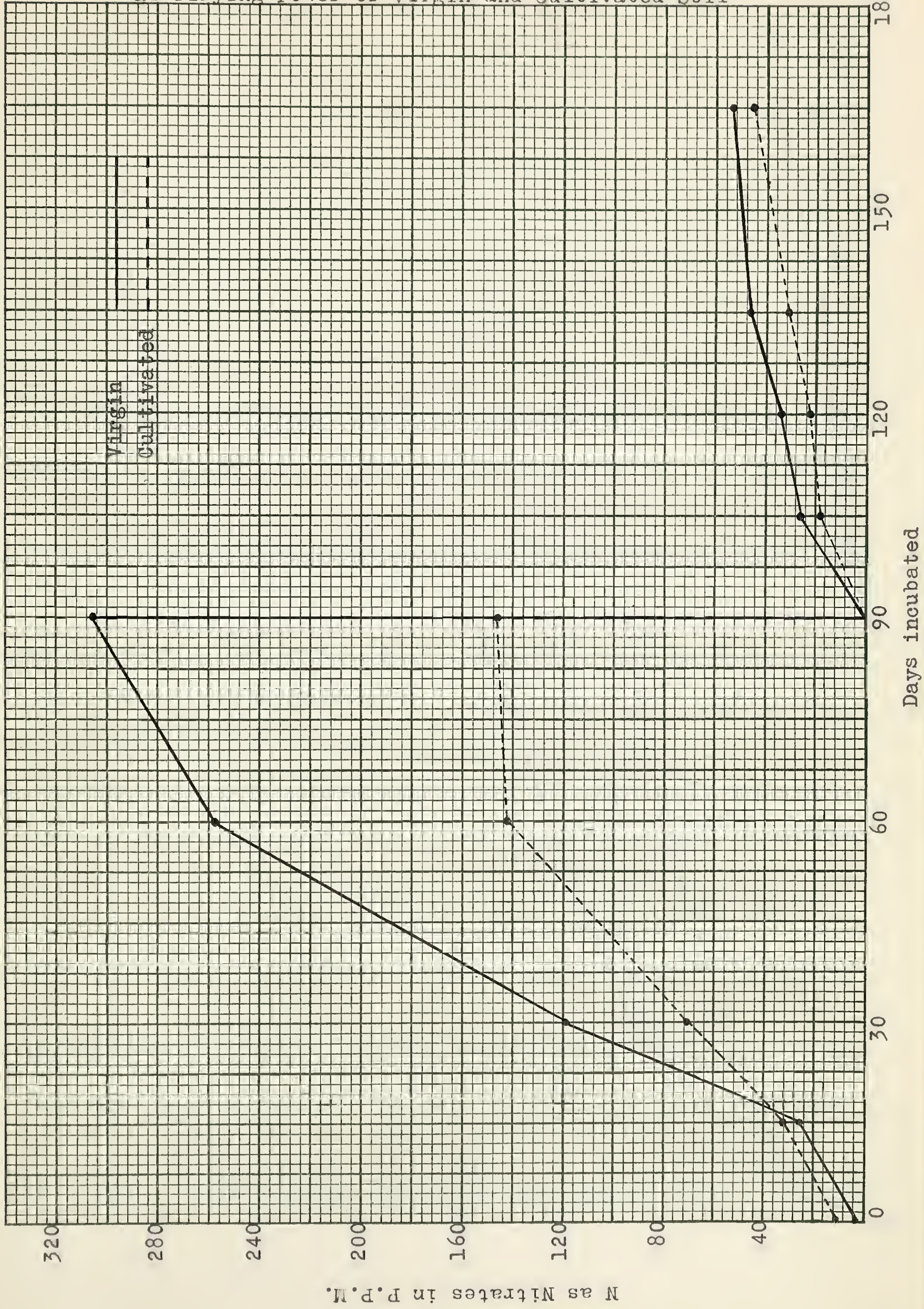
Graph 2

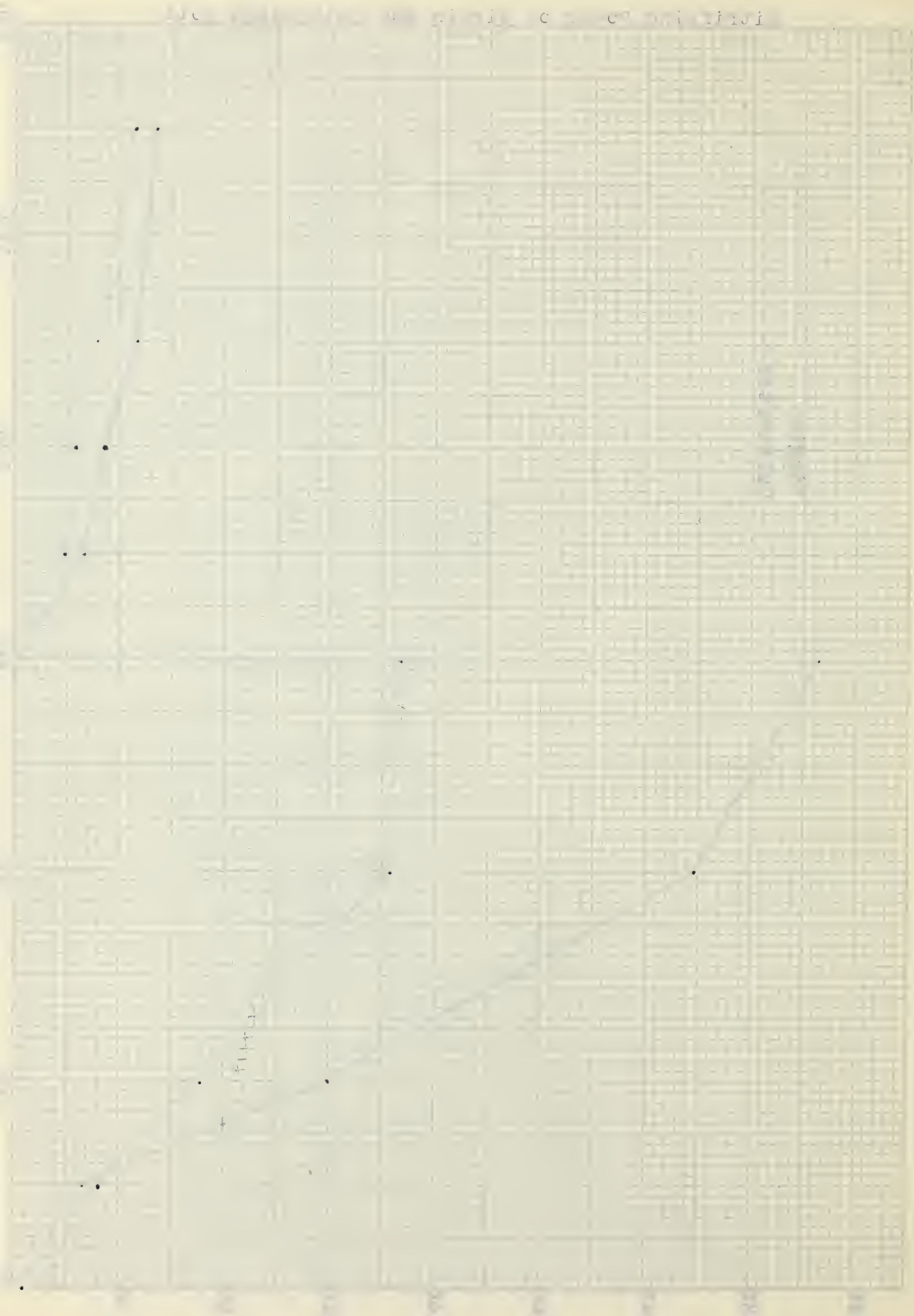
Nitrifying Power of Virgin and Cultivated Soil



MELFORT - Black-L Graph 3

Nitrifying Power of Virgin and Cultivated Soil

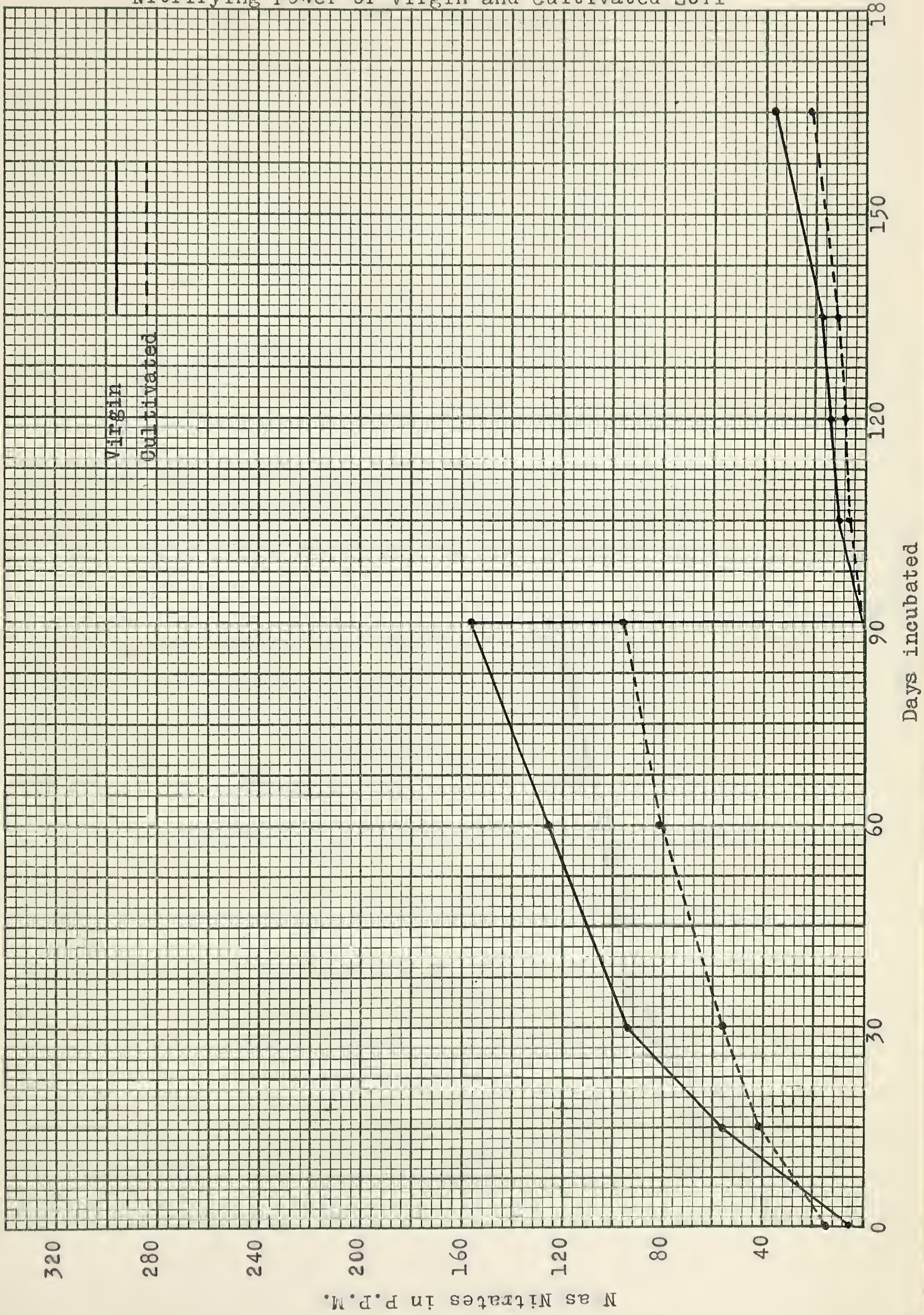




REGINA EAST - Dark Brown-L

Graph 4

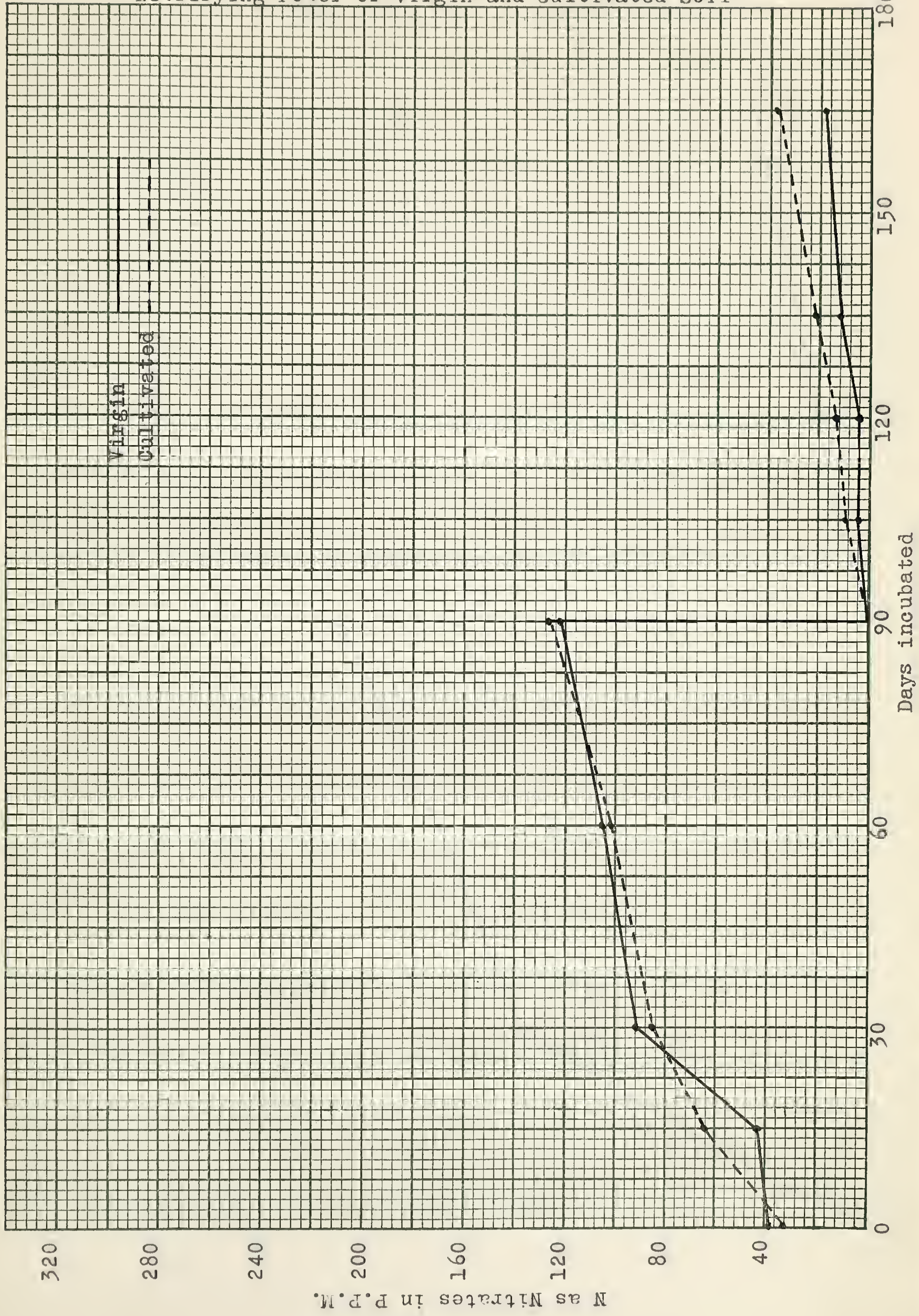
Nitrifying Power of Virgin and Cultivated Soil

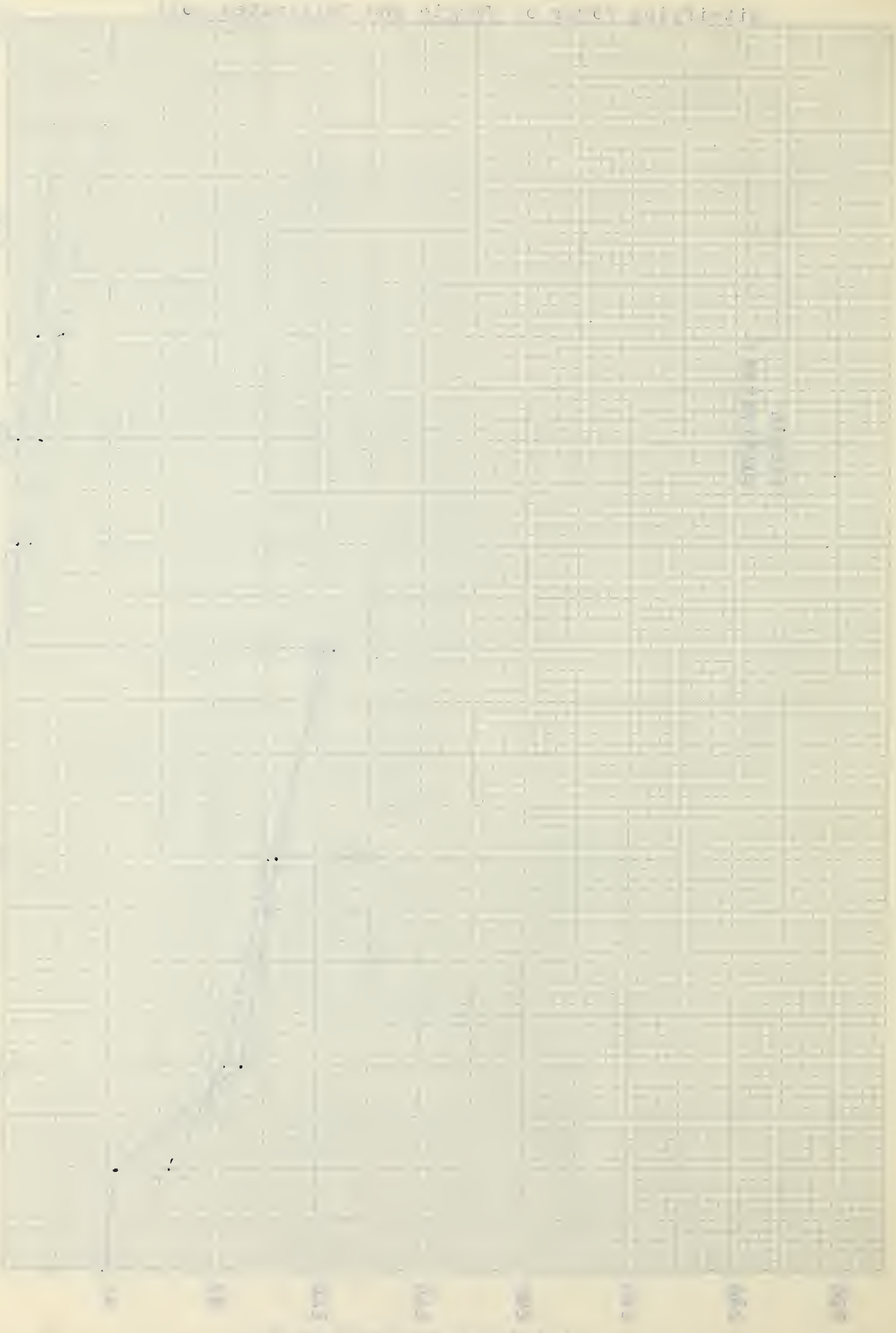


HANLEY - Dark Brown-L

Graph 5

Nitrifying Power of Virgin and Cultivated Soil

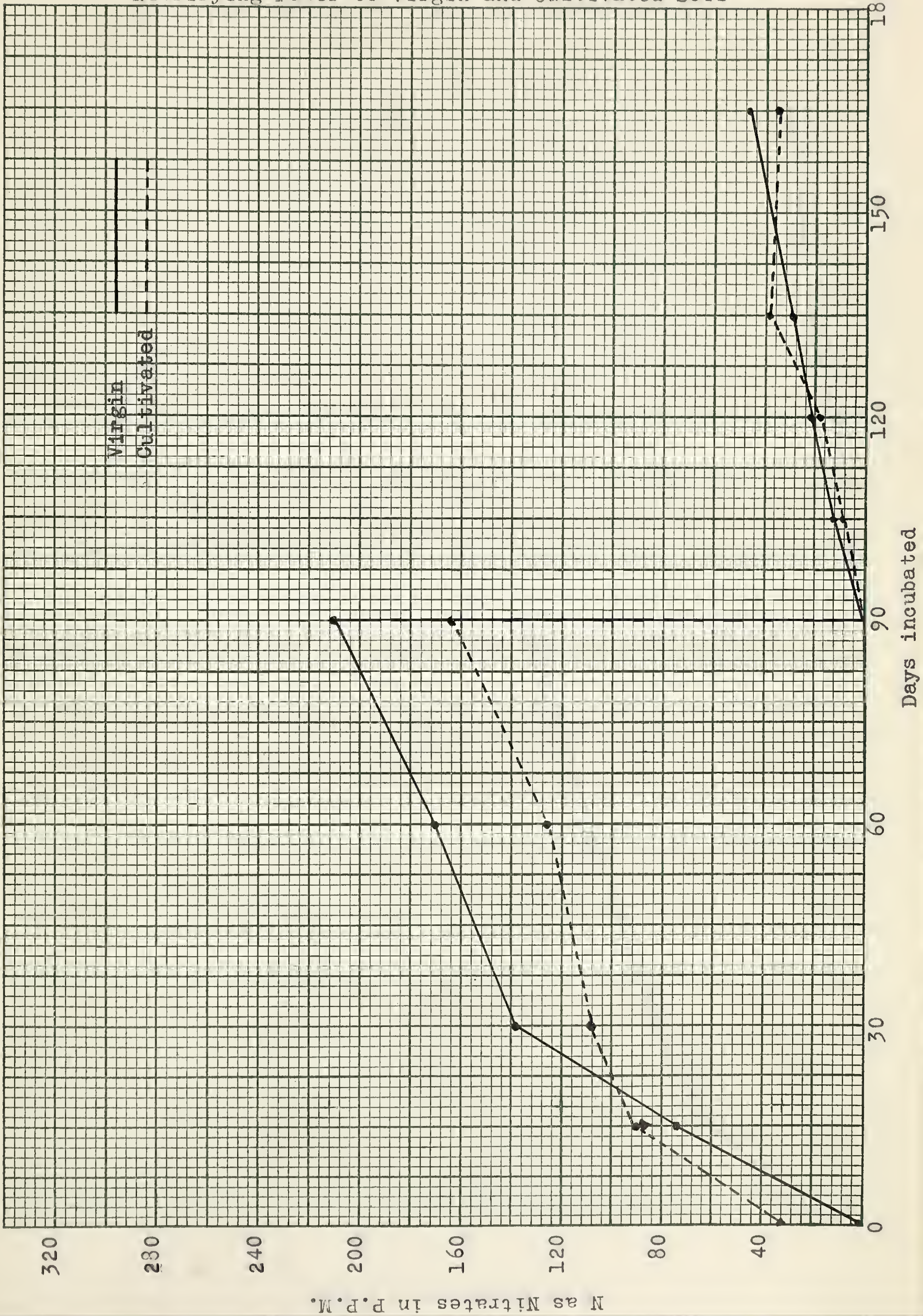




MORRIN - Dark Brown-C

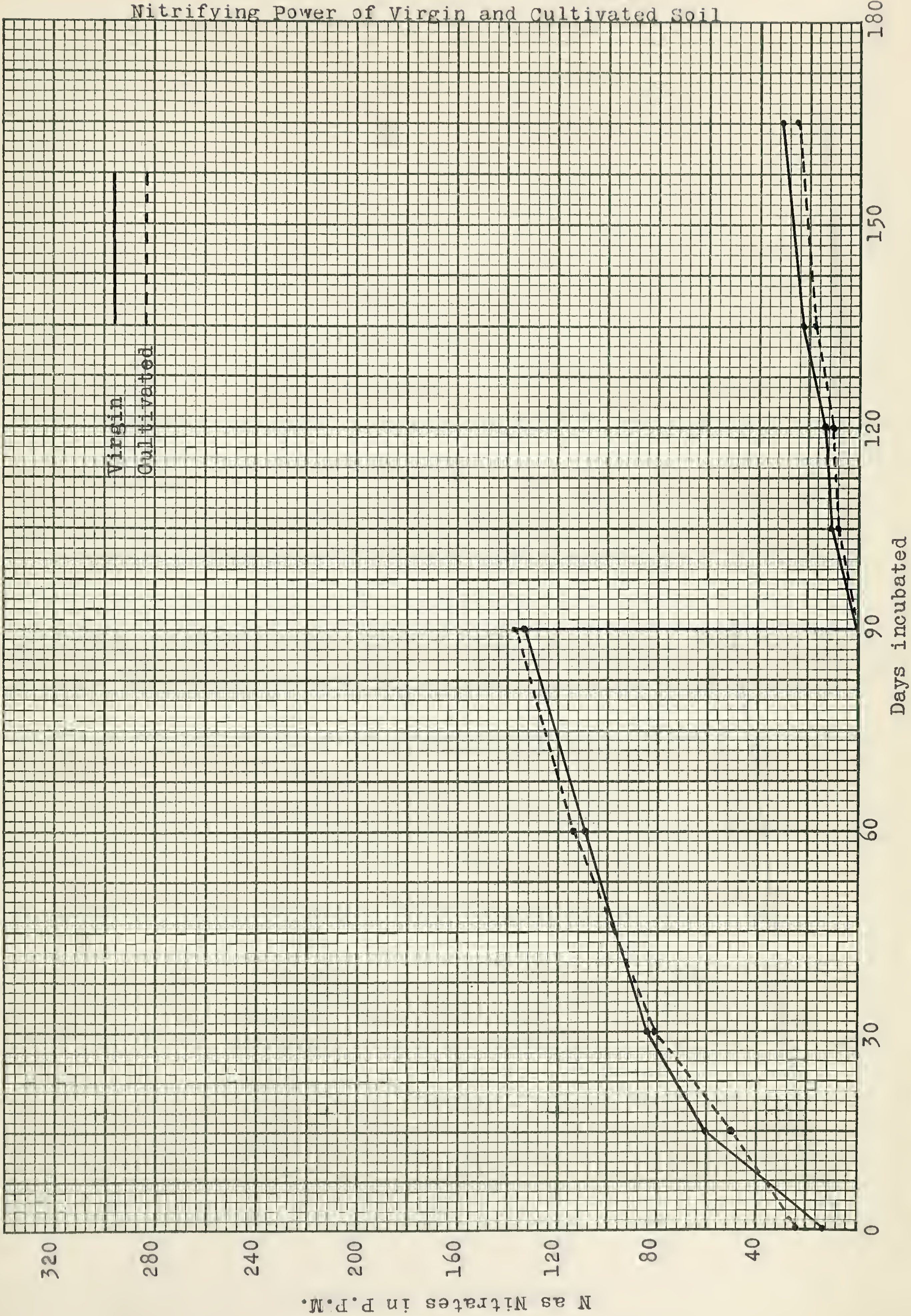
Graph 6

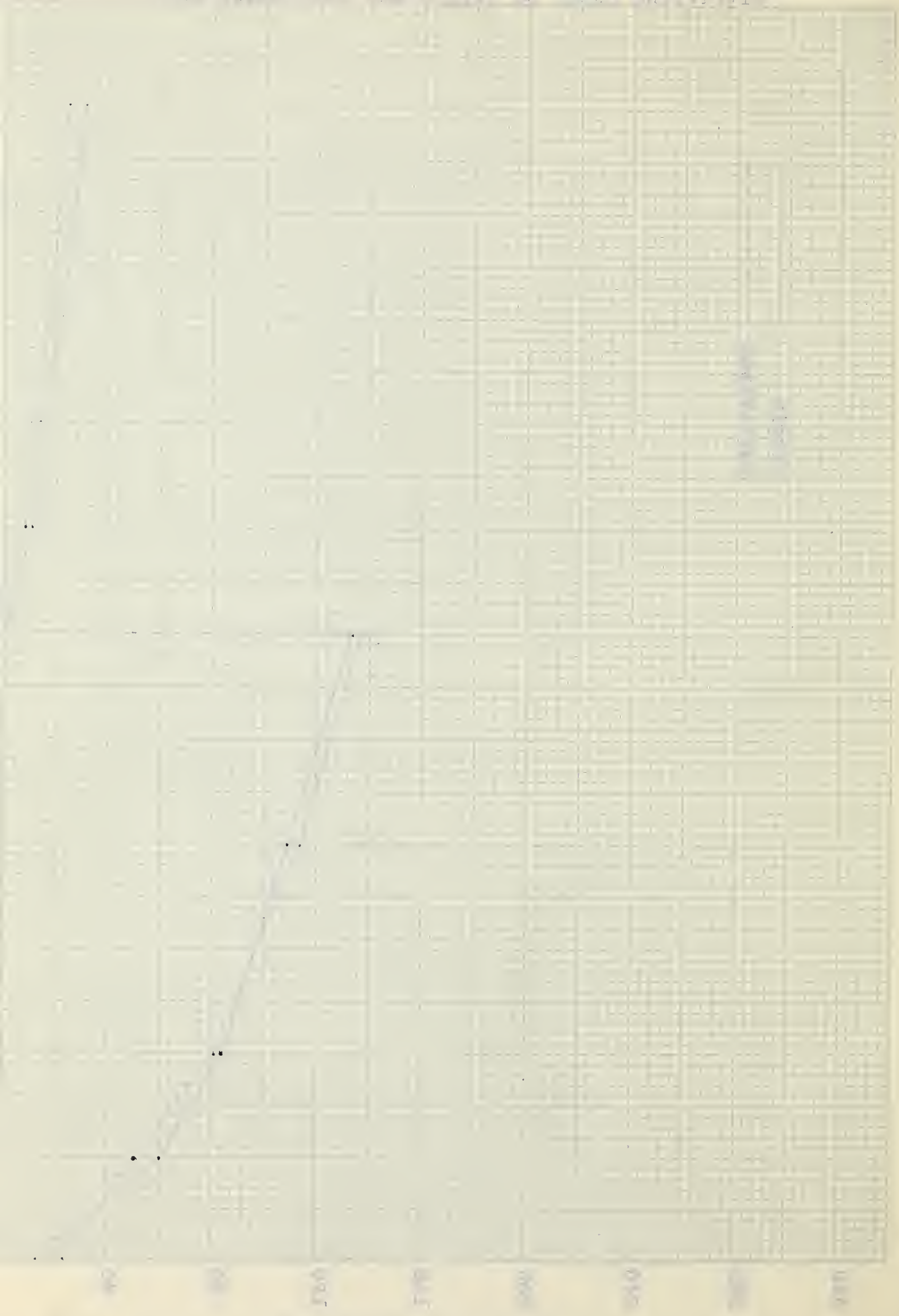
Nitrifying Power of Virgin and Cultivated Soil



SCOTT - Dark Brown-L Graph 7

Nitrifying Power of Virgin and Cultivated Soil

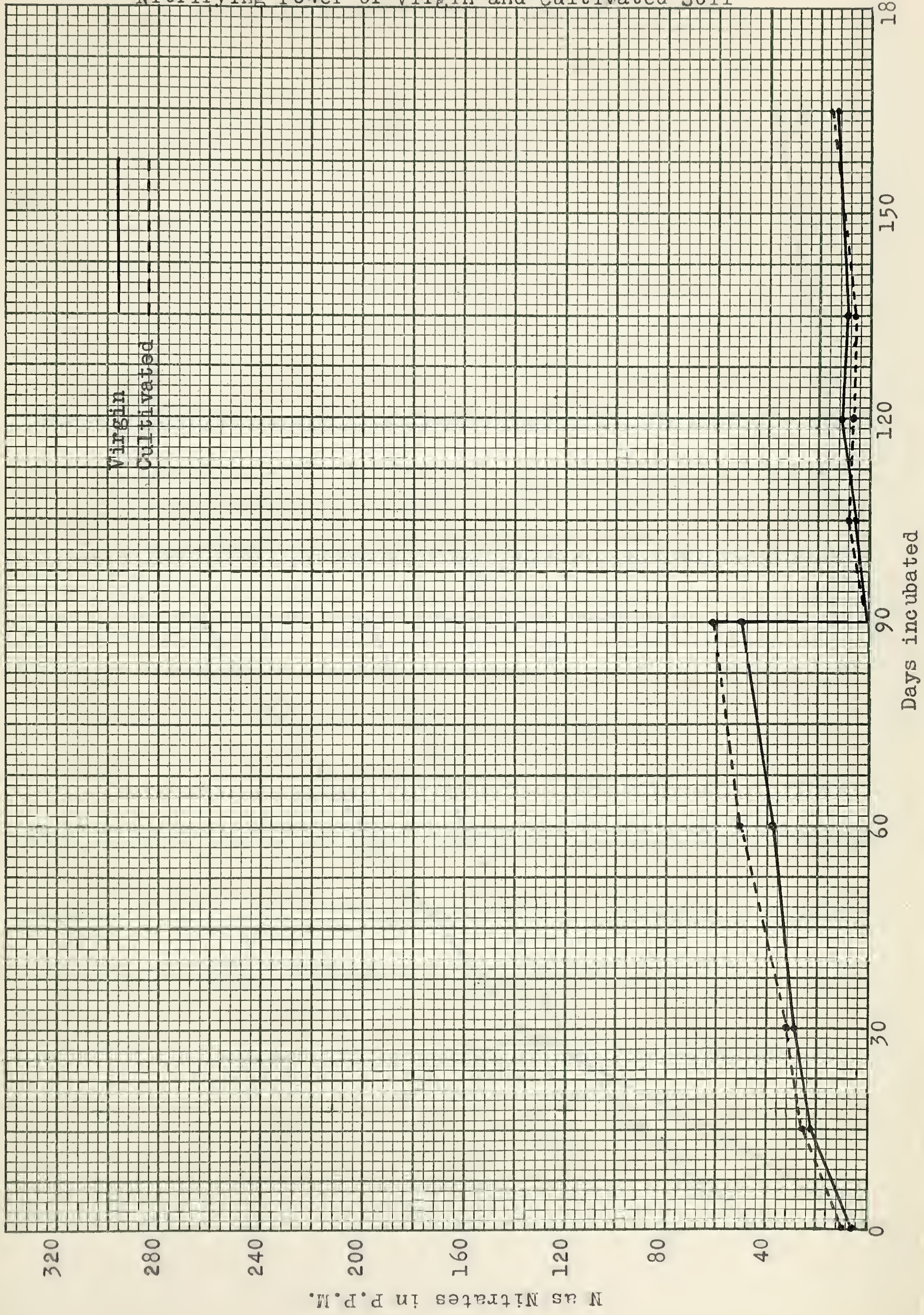




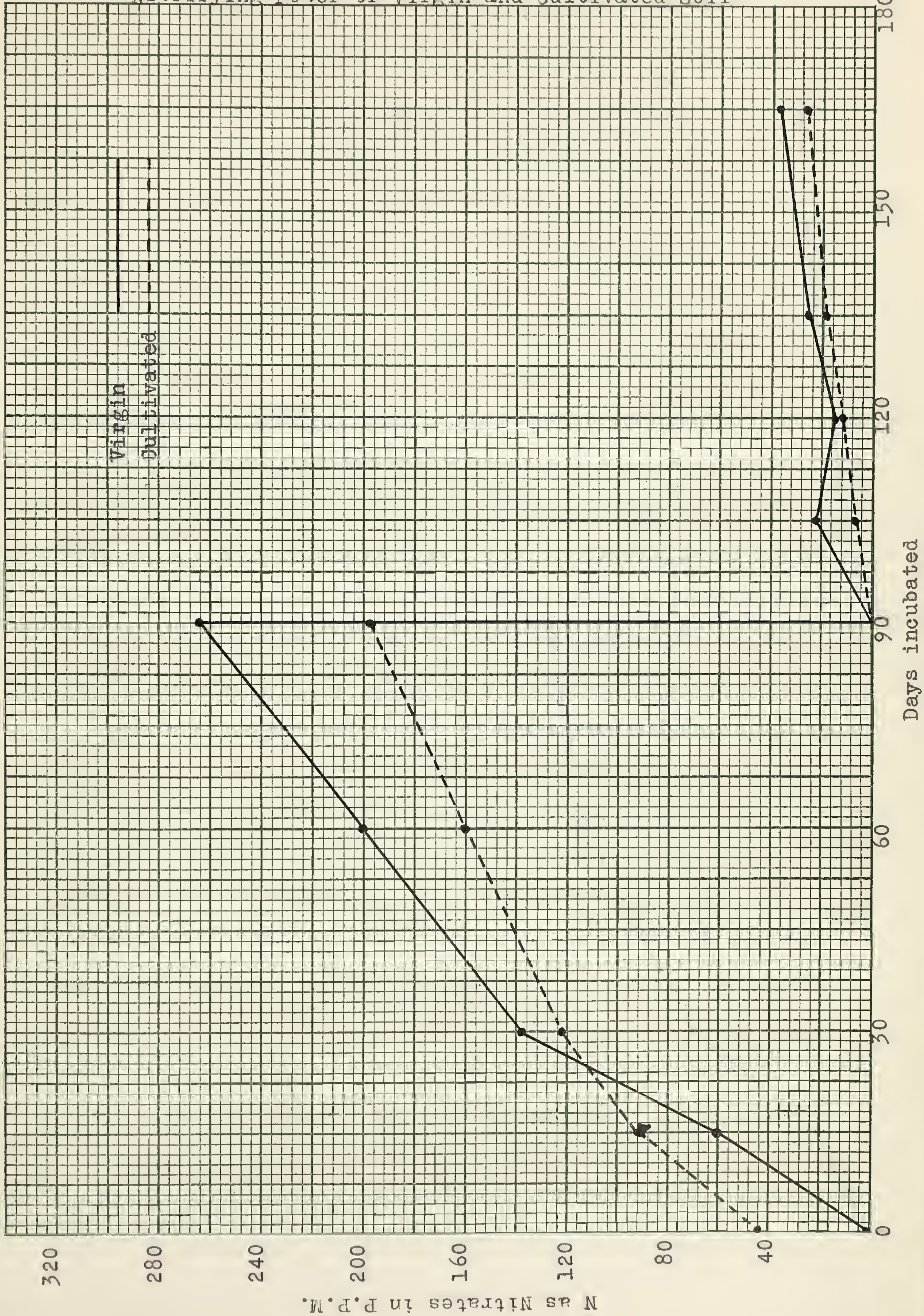
CABRI - Brown-C

Graph 8

Nitrifying Power of Virgin and Cultivated Soil

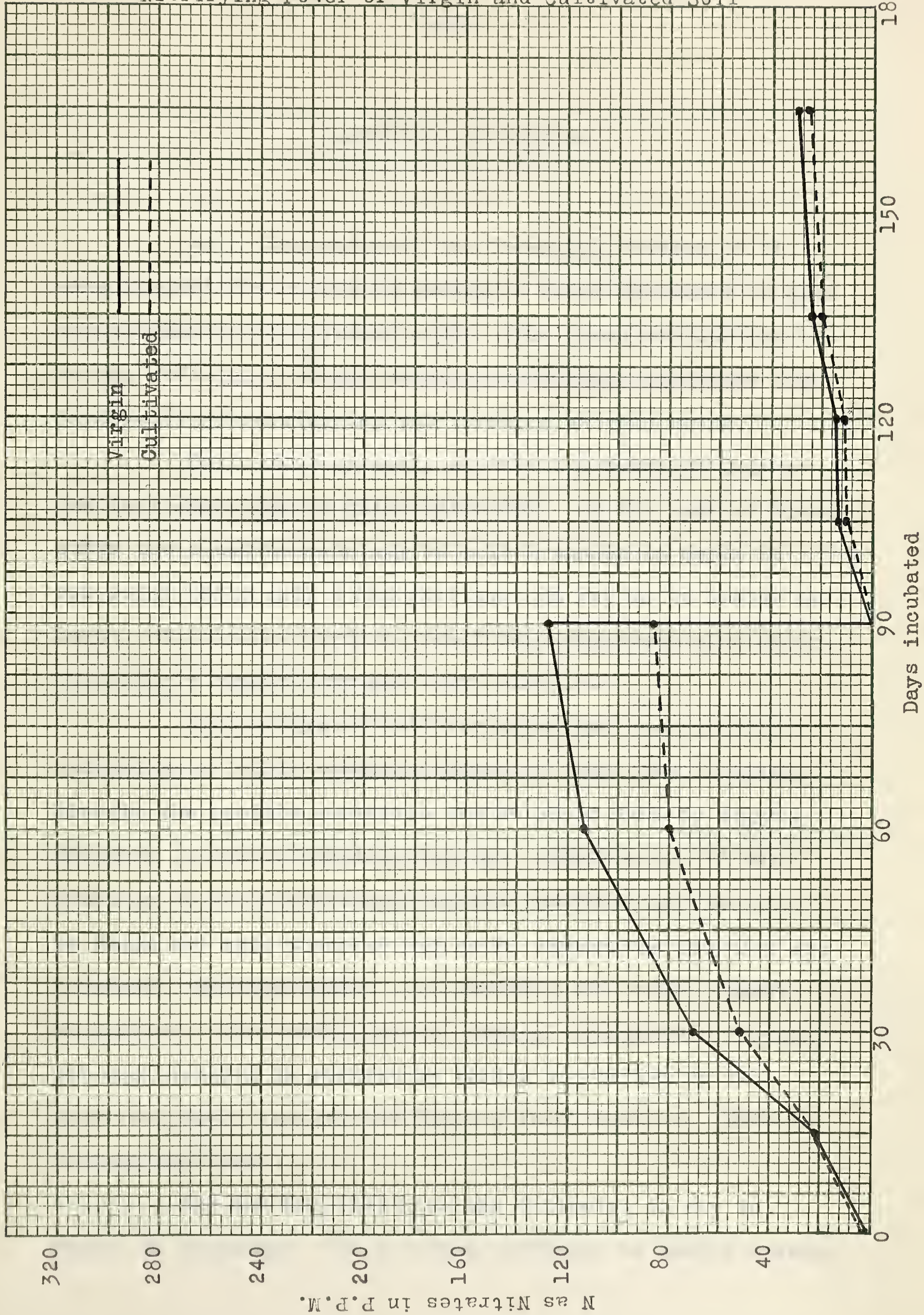


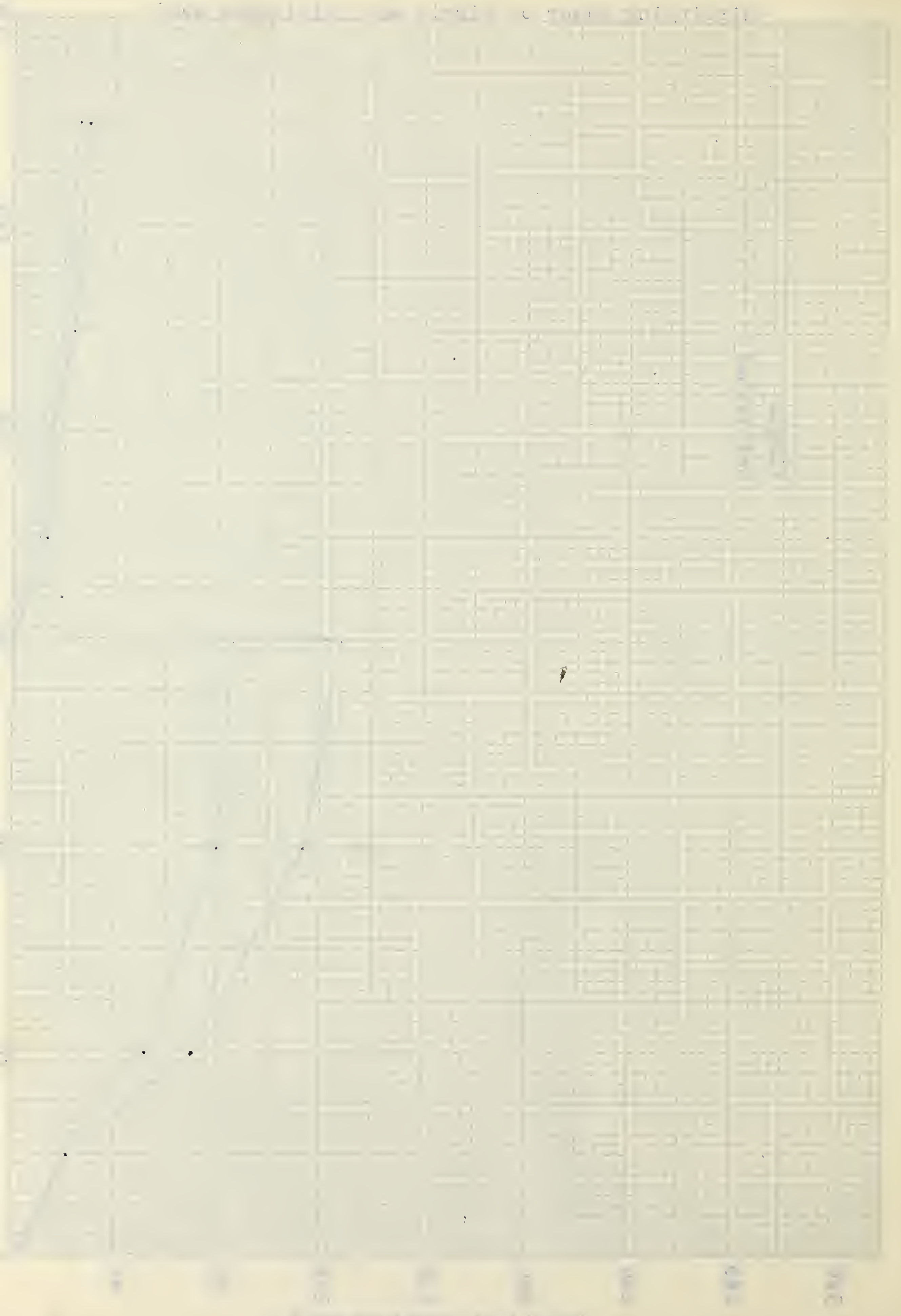
Nitrifying Power of Virgin and Cultivated Soil



CUTKNIFE - Brown-L Graph IO

Nitrifying Power of Virgin and Cultivated Soil





DISCUSSION OF RESULTS

In a discussion of the foregoing results it is essential at the outset to include a brief discourse on soil variability and analytical error. The whole project depends on the efficiency of the sampling technique, and hence the importance of considering the question at this point.

Soils vary greatly, so that two profiles only a few feet apart may be quite different. In the case of black soils the black horizon may be only 8 inches in depth at one point while only a few feet away it may be 14 inches in depth. Within the horizon itself variations may also occur. Thus single samples are not very reliable.

The problem of soil variation has been greatly reduced by a fairly adequate method of composite sampling. Firstly the profile variation can be coped with by digging trenches in the cultivated field and virgin sod. If the profiles do not correspond, uniform locations may have to be found and more trenches dug until comparable profiles are obtained. By this system also drifting can fairly readily be spotted. The variations in chemical composition throughout each horizon is reduced by taking composites of at least ten small samples and lumping them together. This is done in duplicate.

Ogg and Dow (12) have the following to say in regard to sampling: "It is often difficult to decide whether

soils were originally alike and in certain cases it is evident that the land which is now uncultivated was left because it was originally inferior to the land cultivated."

In this investigation it has necessarily been assumed that the cultivated soils were similar in fertility to the nearby virgin sod. It has also been assumed that the virgin sod has changed very little in fertility since the cultivated fields were broken.

The analytical methods employed are all standard procedures and give quite accurate results. A small personal error is no doubt introduced into the analyses but since the error in sampling is liable to be greater than any analytical errors, this personal error may be neglected.

Nitrogen and Organic Carbon

From the standpoint of the effect of cultivation and cropping on the nitrogen and organic carbon in the soils the results herein reported substantiate the findings of Caldwell et al (4,5). Large losses of nitrogen and organic carbon have been shown to occur under a grain-fallow system of farming. In the case of nitrogen Caldwell et al (4,5) point out that there are four factors mainly responsible for losses of this element. These are: crop removal, leaching, erosion (both wind and water), and volatilization. The carbon:nitrogen ratio was found to be narrowed as a result of cultivation and cropping. This also is in line with the results obtained by Caldwell et al (4,5).

An attempt has been made in this work to find out the effect of length of time of cultivation on the loss of nitrogen and carbon; that is, to find out if the losses are more rapid during the first few years after breaking than they are later on. In this connection some interesting calculations have been made from Table 14. For the 0 to 6 inch depth of the older fields, where the average number of years cultivated has been 24, the loss amounts to 2,154 pounds of nitrogen or 90 pounds for a single year. This is enough nitrogen to produce a 45 bushel (per acre) crop of wheat. For the first foot of soil the calculated loss per year is 103 pounds of nitrogen for each acre.

Similar calculations for the newer fields reveal the fact that over an average cropping period of 9 years, the loss has been 1,267 pounds for the 0 to 6 inch depth or 141 pounds of nitrogen per acre per year. For the first foot of soil the loss has been a total of 1,318 pounds or 147 pounds per acre per year. This would seem to indicate that in the first few years under cultivation nitrogen losses are relatively high, and as cultivation is carried on the rate of loss decreases.

Similar calculations for the organic carbon have been made. In this case the losses are proportionately greater but the same trends are revealed. For an average of 24 years of cultivation and cropping the loss of organic carbon in the first 6 inches has been 39,050 pounds (Table 27). In the second depth the loss has been 7,898 pounds and

for the first foot the average loss has been 38,857 pounds of organic carbon or 66,989 pounds of organic matter. This amounts to an annual loss of 1,289 pounds of carbon for the 0 to 6 inch depth, 329 pounds for the 6 to 12 inch depth, and 1,618 pounds for the first foot. Thus the average annual loss of organic matter over a period of 24 years has been 2,789 pounds per acre.

Considering the newer fields (right hand side of Table 27)--for an average of nine years of cultivation there has been a loss of 20,939 pounds of organic carbon in the first 6-inch depth, 3,524 pounds for the second depth, and 24,463 pounds for the first foot. This is equivalent to 42,174 pounds of organic matter in the first foot. The annual loss for these fields has been 2,327 pounds in the first 6 inches or 2,719 pounds in the first foot, equivalent to 4,688 pounds of organic matter in 12 inches of soil.

Again the indications are that organic matter is rapidly lost immediately after the field is broken and then the rate decreases as time goes on.

These facts substantiate the general belief that once the virgin sod is broken the oxidation of organic matter is quite rapid. No doubt if figures were available for the first year after breaking, the loss in that year would be the greatest. As cultivation and cropping is carried on evidently a sort of equilibrium is reached and the rate of loss becomes slower and probably more uniform. The organic matter present in the soil after ten years of cultivation

has been greatly reduced, and thus it naturally follows that the amount lost per year would then be less. In any case, even after 25 years of cultivation, the fields are still evidently losing large amounts of organic matter annually.

Phosphorus

The phosphorus results are much less definite than those for the nitrogen and organic carbon. Caldwell (4) was unable to arrive at any satisfactory conclusions regarding the behavior of phosphorus as affected by cultivation and cropping. Considerably more data has since been accumulated, as results from 50 locations for phosphorus determinations have already been presented in the previous pages. The results show average losses of total phosphorus from the first 6 inches of cultivated soil to be 105 pounds for black, 143 pounds for dark brown, 144 pounds for brown, and 101 pounds for gray soils. Evidently the brown and dark brown soils have lost the greatest amounts of phosphorus. Below the 6-inch depth the results are less accurate since the gains or losses are of an extremely low order. It seems safe to say that from this work only the analysis of the first 6-inch layer indicates a loss of phosphorus.

In attempting to find out the effect of length of time of cultivation on the loss or gain of phosphorus, calculations similar to those for nitrogen and carbon were made. From Table 37 the annual loss of phosphorus for 24 years for the first foot was calculated to be 6.2 pounds.

For a period of nine years the newer fields apparently lost annually in the first foot 10 pounds of phosphorus. These calculations indicate that phosphorus has apparently been lost more rapidly in the first few years of cultivation than later on. The individual figures in this Table 37, however, show a greater fluctuation than was true for the nitrogen and carbon figures. Thus these average phosphorus figures may not be of very much significance. No doubt further information is required along these lines before anything definite can be concluded.

Easily soluble phosphorus in cultivated black soils appears to be lower than in the corresponding virgin soil. However, in the case of the dark brown and gray soils the reverse appears to be true. The brown soils on the average appear to have about the same amount of easily soluble phosphorus in the cultivated as in the virgin soil. The easily soluble phosphorus is supposed to be the phosphorus that is readily available to the plant. It is a known fact that this varies from day to day and it does not necessarily depend on the total amount of phosphorus present in the soil. Because of these variations and also because of the non-uniformity of results for the various soil zones it is rather difficult to make a general statement concerning the effect of cultivation and cropping on this fraction of the phosphorus. Apparently further information is required before any conclusions can be drawn.

In regard to the water soluble phosphorus in soils,

apparently cultivation and cropping have had an effect. At 54 out of 62 locations less water soluble phosphorus is present in the cultivated than in the virgin soils. Although these differences are for the most part very small, the lower value in the cultivated soil is consistent for all four soil zones. The water soluble phosphorus is also subject to variation from day to day or week to week as is true for the easily soluble phosphorus. Nevertheless the consistency obtained in the water soluble phosphorus results would indicate that the virgin soil contains more water soluble phosphorus than does the cultivated soil.

Nitrification

The nitrification studies have shown some interesting results. In most cases the cultivated soil contains more nitrate at the beginning of the incubation period, but after 30 to 40 days the virgin in most instances takes the lead. In eight out of ten cases the virgin soil has the greater nitrifying power as shown after a period of 90 days incubation. In the cases of Hanley and Scott the virgin and cultivated soils appear to have similar nitrifying power at least after 90 days incubation.

Nitrifying power of both virgin and cultivated soils was greatly reduced after leaching the nitrates, etc., out of the samples. This was true in every case. The amount of nitrates produced after leaching occurred was very small even up to 105 days of incubation. However, in most cases the

virgin maintained a slight lead in nitrifying power over the cultivated soils. One notable exception was Hanley soil which showed the cultivated to have slightly more nitrifying power after leaching than the virgin soil.

SUMMARY

Total nitrogen, organic carbon, total phosphorus, easily soluble phosphorus and water soluble phosphorus have been determined on some virgin and cultivated western Canada prairie soils. Nitrification studies have been carried on with some of the surface samples. Carbon: nitrogen ratios have been calculated from percent organic carbon and percent nitrogen.

Nitrogen

Thirty-nine out of 51 cultivated fields have shown losses of nitrogen va rying from 132 pounds to 7,242 pounds per acre to the depth analyzed.

On the average for the surface 6 inches the cultivated black, dark brown, brown, black transition, gray transition and gray soils have lost 1,667 pounds, 1,090 pounds, 989 pounds, 2,693 pounds, 1494 pounds and 404 pounds per acre respectively. This amounts to a loss of 15% to 25% of the original nitrogen present in the surface layer of the virgin soil.

For the 6 to 12 inch depth the black and black transition cultivated fields have lost on the average 688 pounds and 388 pounds of nitrogen per acre respectively. The other zones showed much smaller losses for this layer, gray transition revealing an average increase of 180 pounds.

Results indicate that the largest losses of nitrogen

have occurred from soils originally high in nitrogen. The results reported also indicate that the loss of nitrogen is more rapid for the first few years following cultivation.

Organic Matter

Forty-three out of 51 cultivated fields have shown losses of organic matter ranging from slightly over one ton to over 90 tons per acre to the depth analyzed.

On the average the surface six inches of cultivated black, dark brown, brown, black transition, gray transition and gray soils have lost 40,278 pounds, 30,036 pounds, 28,696 pounds, 70,213 pounds, 37,549 pounds and 17,170 pounds per acre of organic matter respectively. This amounts to a loss of 21% to 32% of the original organic carbon present in the surface layer of the virgin soil.

Losses are shown in all cultivated fields, on the average in the 6 to 12 inch depth, except in the case of gray transition soils. Black and black transition zones show the greatest losses in this layer, namely, 16,102 pounds and 12,635 pounds per acre of organic matter respectively.

In all zones but the gray soil zone the average figures show that losses have occurred in the cultivated fields even below the 12-inch depth. However, composite samples below 12 inches were not obtained and so these losses may be more apparent than real.

Thus the evidence that the grain-fallow system does not maintain the organic matter has been substantiated.

Results indicate that the largest losses of organic carbon have occurred from soils originally high in organic carbon. The results also indicate that the greatest losses occur in the first few years after the virgin sod is broken.

Carbon:Nitrogen Ratios

Forty-three out of 51 cultivated fields have shown a narrowing of the carbon:nitrogen ratio in the surface layer as a result of cultivation and cropping.

Thirty-six out of 51 cultivated fields have shown a narrowing of the carbon:nitrogen ratio in the subsurface layer; while 16 out of 25 have shown this effect in the subsoil.

The carbon:nitrogen ratio has been found to be narrower in the subsoil and sub-surface than in the surface, both in the case of virgin and cultivated soils.

This substantiates the evidence that the organic carbon is depleted relatively faster than is the nitrogen. It is interesting to note that the gray soils originally had by far the widest carbon:nitrogen ratios, and also that they show the greatest narrowing of the ratios in the cultivated soils.

Total Phosphorus

Thirty-five out of 50 cultivated fields have shown losses of phosphorus varying from 36 pounds to 1,386 pounds per acre to the depth analyzed.

The surface 6 inches of the cultivated black, dark brown, brown and gray soils have lost on the average

105 pounds, 143 pounds, 144 pounds and 101 pounds per acre respectively.

Losses or gains below the 6-inch depth have not been established. Apparently cultivation and cropping have resulted in a decrease of phosphorus in the surface layer.

Easily Soluble Phosphorus

The results for easily soluble phosphorus have not been very uniform. The cultivated black soils appeared to contain less easily soluble phosphorus than the virgin soil, but in the dark brown and gray soil the reverse appeared to be the case. The brown soils have not shown much difference between virgin and cultivated soils in regard to content of easily soluble phosphorus.

Water Soluble Phosphorus

Fifty-four out of 62 cultivated fields have shown less water soluble present than the corresponding virgin soils. The differences for the most part have been small but the decrease due to cultivation has been uniform for all four soil zones.

Nitrification

Nitrification studies on some surface virgin and cultivated samples have shown that in seven out of ten cases the virgin soil has the greater nitrifying power after a period of three months incubation.

Leaching has been shown to greatly reduce the nitrifying power of both the virgin and cultivated soils, although in most cases the virgin soil still had a slightly greater recovery power.

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